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NOTES ON A NEW INFUSORIAN.

BY DR. ALFRED C. STOKES.

EARLY in the spring of last year (1883), I gathered a quantity of Lemna from a pond whose surface was so completely covered by the little plants that they seemed to be jostling each other for growing room. The water beneath must have been quite dark, being lighted probably only by so much of a faint green glimmering of sunbeams as the Lemna could transmit, yet that shallow pond contained myriads of living creatures. For eight months or longer the gathering has stood neglected upon my table, a little fresh water being occasionally added to supply that lost by evaporation, and it is still clear and untainted, although every frond has lost its rootlets, and the greater number have gone to decay, and though many generations of Infusoria, rotifers and Turbellarian worms have come and gone, and added their little to the residual detritus covering the bottom of the vessel. The Infusoria, therefore, now living within the restricted habitat of this glass saucer cannot be considered as Infusoria of putrid waters, and those recently appearing there in midwinter are probably from germs forced into development by a kind of hot-house process in a warm room. The same forms might be taken in season from the original pond itself. They seem, however, to have hitherto escaped observation, and as they possess structural peculiarities which, so far as the writer can learn, are limited to their own little bodies, it is necessary to erect not only a new species for their reception, but a new genus.

The body of the Infusorian, which I have named *Ctedoctema acanthocrypta*, gen. et sp. nov., is soft and flexible, but persistent in

shape, its form being elongate-ovate, subcylindrical and slightly compressed, widest and rounded posteriorly, thence tapering evenly to the obtuse mesially placed anterior point. The entire cuticular surface is ciliated, the cilia being long and fine, their length often exceeding the short diameter of the body. They are arranged in rows that are more distinctly seriate on the dorsal aspect. Ventrally their arrangement is more irregular, and here they seem to be constantly in motion. All are flexible and all are at times put into vibration, but each individual filament upon the lateral and dorsal surfaces is capable of independent movement. When their tips are focussed, scattered cilia are seen to tap and patter against the cover-glass, and the four or five stiffer, more setose hairs projecting from the posterior extremity quiver and occasionally lash the water as if the animal had hardly time to eat. One of these postero-terminal cilia has its distal extremity conspicuously curved, as is shown in the figures. When the infusorian is at rest, the cuticular cilia, with the exception of those on the ventral aspect, do not vibrate, but stand out from the surface like long bristles; at such times the only additional actively moving cilia are those of the oral series and a single row on the left lateral body margin. As the creature is rapidly swimming, to distinguish whether any or all of the cilia are in motion is next to impossible. It is only during the moments preceding death by iodine poisoning that the question can be answered, as it is in the affirmative, not a cilium then being idle.

In its movements the creature is wonderfully swift, darting across the field so quickly that the looker-on can only see that something has passed by. Even when a pleasant feeding ground is discovered under the lee of an algous filament or a patch of dirt, the lively animal cannot rest, but at frequent and almost regular intervals darts forward for one-half its length and as quickly slips back to its former position. In this rhythmic swing it seems to use the tips of the supporting cilia as fulcra, thus converting itself into an animated lever of the third class, where the power is between the weight and the pivot.

In Fig. 1 Ctedoctema is represented in its dorsal aspect, drawn with the camera lucida and magnified 700 diameters. Its extreme length is $\frac{1}{100}$ inch. The nucleus, as shown in the figure, is ovate, and situated about mesially in the anterior body half. The pul-

sating vacuole, sub-terminally located below and to the right of the median line, contracts at intervals of six seconds.

The infusorian has the inexplicable habit of protruding sub-terminally on the left dorso-lateral margin, a colorless, semi-transparent hemisphere of the body sarcode, in which there is often a circulation of the minutely granulate protoplasm. The object of this bubble-like protrusion, as intimated, I have been unable to determine. It was at first mistaken for the beginning of a temporary anal aperture, but such use of it has not been observed. It is frequently withdrawn, leaving a lighter smooth spot in its place.

But it is on the ventral surface that we find most of the creature's peculiarities. Originating at the anterior margin and ex-

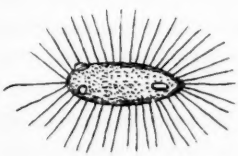

Fig. 1.

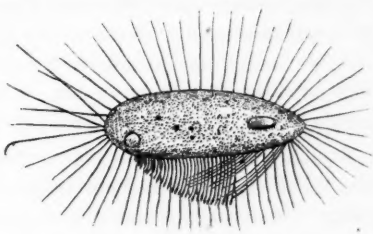

Fig. 2.

FIG. 1.—*Ctedoctema acanthocrypta*, gen. et sp. nov. Dorsal aspect. × 700. FIG. 2.—Lateral aspect.

tending almost centrally across the ventral surface, but somewhat obliquely backward and inward, for a distance equal to three-fourths of the animal's entire length, is a shallow, narrowly ovate groove, at whose posterior and widest and deepest part the oral aperture is placed. This depression, narrowest at its anterior origin and gradually and regularly widening to its rounded posterior termination, is clothed with long fine cilia for about two-thirds of its length. The longest of these vibratile hairs are in length nearly equal to the animal's transverse diameter, being longest and somewhat fasciculately clustered on the extreme anterior margin, thence becoming gradually shorter until about two-thirds of the groove are supplied. They seem to be absent from the remainder of the depression with the exception of the space immediately around the oral aperture, where they are visible only in their effect and in the peculiar glimmering appearance which they produce, that shimmering of the surface like the wavering of heated

air which one so soon learns to associate with the action of fine cilia. When the animal is swimming, those anteriorly placed are snugly packed away longitudinally in the adoral groove. Occasionally they are quiescent long enough at other times to exhibit their length and tufted arrangement, when they are held arcuately parallel with and below the adoral depression.

Near the left hand margin of this elongated sinus is a single row of long fine vibratile cilia, whose points of attachment are much more widely separated than those on the general cuticular surface. Their vibrations seem to be at right angles to the course of the adoral groove, but the facility with which the direction of movement in such delicate filaments may be misinterpreted is remarkable. After those intervals, few and far between and at best of but momentary duration, when they become quiet and visible, their action certainly seems to be renewed, and they to fade from view, as the animal lies upon its side, not by a lateral sweep but by a downward flashing of the whole series; that such is the fact, however, I am not prepared to say; it only seems so.

Attached to the right margin of the adoral sinus is a symphony in cilia which, so far as I am aware, is possessed by no other infusorian. It is really musical in the beauty and the harmony of its arrangement. The ciliary constituents of this delightfully satisfactory series are each much coarser and stouter than any others on the creature. Placed in a single row and slightly curving over the adoral depression, they begin anteriorly at a distance from the frontal margin equal to about one-third of the entire length of the groove, the first and foremost cilium being scarcely shorter than the animal's transverse diameter, the length of each succeeding one becoming a little less than the preceding, until the last just rises above the surface immediately behind and somewhat to the left side of the oral aperture. Each member of this comb-like appendage not only curves in accordance with the regular curvature of the series, but has a distinct thickening of its distal extremity whereby that free end is brought into apparent contact with its neighbor. Under insufficient magnifying power this state of affairs presents the aspect of a long curved posteriorly originating flagellum, or the lowermost outline of an adoral hood; and when thus examined the animal presents a striking resemblance to Pleuronema or Cyclidium. Indeed, we have only to imagine the former as having divided its hood-like velum

longitudinally and split up each moiety into transverse filaments, when the resultant creature would bear a strong likeness to Ctedoctema, and would probably be relegated to the same genus. As it is, the observer must be in some doubt as to the ordinal position of Ctedoctema. Does it, in common with Cyclidium and Uronema, belong to the Ciliata-Holotricha, or to the Ciliata-Heterotricha? The boundary between the two orders is so indistinctly defined that the doubt becomes a serious one.

However, the cilia which have led me into this side issue remain standing, like the sentinels they are, beside the adoral sinus. While the animal is feeding they are not actively vibratile, although the whole row has the power of bending in a body across the groove. I have seen them waving back and forth in an unbroken line like an animated comb. Each member of the group also has the ability of separately bending in a direction away from the median line, and it uses this accomplishment when a food-particle, too large or otherwise unacceptable, must be discarded, several often flirting themselves in unison outwardly when there is too great an accumulation about the oral aperture. When their possessor is swimming they are drawn up against the ventral surface parallel with the margin of the adoral groove, and consequently in contact with each other, their free ends thus pointing posteriorly.

I have found it quite impossible to use the camera lucida in drawing the details of these active little animals. The figures are therefore more or less diagrammatic, with the exception of the first. In the second (Fig. 2) an attempt is made to show the animal in its lateral aspect, with the coarse comb of adoral cilia, the anterior ciliary tuft and the single row of long, laterally-disposed vibratile hairs, as well as the nucleus and the contractile vesicle. In Fig. 3 Ctedoctema exhibits its ventral surface, especially the adoral groove, with the ciliary comb on its margin, laterally curved above it and surrounding its termination posteriorly.

The trichocysts, found, it is said, only in the flesh of members of the Ciliata, are numerous in Ctedoctema, huge in proportion to the size of the infusorian, and possessed of peculiarities not hitherto noticed in connection with those of any other member of the class. The action of the recently-recommended solution of tannic acid in glycerine for the purpose of rendering trichocysts conspicuous, is eminently successful and satisfactory.

When killed by this mixture, Ctedoctema becomes a nondescript object, woolly with distorted cilia, and having trichocysts like great darning-needles projecting from various parts of the surface. They are occasionally so violently extruded that they leave the body and fall away free. The infusorian is $\frac{1}{1000}$ inch in length; the trichocysts are $\frac{1}{2000}$ inch long, precisely one-half Ctedoctema's greatest length, and but a fraction shorter than its transverse diameter. Under suitable amplification they are visible within the living animal. Those of the posterior extremity are arranged nearly parallel with the median line; those of the posterior body half are directed forward, those of the anterior half backward, toward the center of the creature. They are rigid and straight, and, for their length, coarse and stout. They project slightly beyond the cuticular surface and often give the

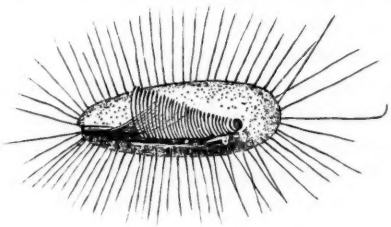

Fig. 3.

Fig. 4.

FIG. 3.—*Ctedoctema acanthocrypta*, ventral aspect. FIG. 4.—Trichocyst with radiating processes.

infusorian, in optical section, a minutely crenated outline. Although so skewered the body is still soft and flexible.

From their distal end they taper evenly to an obtuse point, and seem to be prismatic. The structural parts which I think have hitherto not been noticed with those of any other infusorian, consist of four, occasionally of only two linear processes radiating from the body of the trichocyst, like the finger-boards on the sign-posts at country cross-roads, as shown in Fig. 4. These projecting filaments, measuring $\frac{1}{10000}$ inch in length, are of extreme delicacy, and take their origin at a distance about equal to one-half their length below the distal extremity of the trichocyst. Their direction is not always at right angles to their support, but frequently, even in those of the same individual, they project upward or downward, or form angles of various degrees.

The oral aperture is not followed by a distinct pharyngeal

passage, and although I have never observed food-particles enter, yet judging from the presence within the sarcode of small green corpuscles, which I have taken to be of vegetable origin, I suppose Ctedoctema is a vegetarian. Neither has an anal opening been distinctly noticed. Upon several occasions what has appeared to be an extrusion of excrementitious matters has taken place posteriorly to the oral aperture and back of the ciliary comb, but the flow of rejected food-particles brought by the adoral currents is so great and so constant, that the question is still an open one.

As to the fashion of its reproduction: Is it as whimsical in its manner of renewing its youth as in its adoral anatomy? In one respect, yes. In one respect it goes about that business in a way to surprise the on-looker who has become familiar with every style of fission and with several varieties of cystic sacs, and in a way, too, that makes him pause a moment to admire the exhaustless resources of a divine mind.

That reproduction is by transverse fission goes without saying. But if only that, imagine, if you can, what becomes of all the complex ciliary arrangement about the oral region. The creature to be fashioned from the posterior half of the mature body must have not only a ciliated adoral sinus and the comb-like appendage, all of which simple division crosswise would give, but it must somehow obtain that ciliary fascicle at the anterior apex of that sinus. The posterior termination of the old Ctedoctema's groove has no such tuft to give the new creature, and the latter cannot, at least does not, exude sarcode filaments that shall stiffen into cilia. Then, when and how? Oh, it is so simple and so easy when it is once thought of! But no one ever would think of it without seeing it.

It is in this way: The cilia of that comb deliberately unite laterally and form a membrane. The anterior cilia of the sinus unite with it and lengthen the membrane to the front, the newly-formed tissue being widest somewhat in advance of its center, and narrowing toward both ends. The animal then separates across the middle, forming two Holotrichous creatures, each with a perfectly smooth, unwrinkled membrane vibrating somewhat obliquely along the center of its ventral surface, the free edge of this tip-tilting tissue being distinctly and strongly thickened. What scheme of classification has a place for them

now? If they and the systematist should have a temporary encounter, what would he do with them? Would each be a fresh-water Lembus? Such questions give them no trouble. They at once proceed to form their ciliary appendages by splitting up their membrane to suit. The fringes unite to form the membrane, the membrane divides to form the fringes, the thick edge then going into the thickened extremities of the adoral comb. In two hours, more or less, the sweet-water Lembus is a sweet-water Ctedoctema, of which the following may be taken as a description:

Ctedoctema, gen. nov. (Greek, *ktedon*, a comb; *ktema*, a possession).—Animalcules free swimming, more or less ovate, persistent in shape, entirely ciliate; oral cilia diverse to those of the cuticular surface; oral aperture ventral, located at the posterior termination of a longitudinal, ciliated, adoral depression or groove which bears on its right-hand border a row of large arcutely curved setose cilia gradually diminishing in length toward the oral aperture, which they surround, and with their distal extremities conspicuously thickened; several long, setose hairs projecting from the posterior extremity of the body, usually a single one being distally curved; contractile vesicle single, posteriorly placed; trichocysts large and numerous.

C. acanthocrypta, sp. nov. (Greek, *akantha*, spine; *kruptos*, concealed).—Body elongate-ovate, widest and rounded posteriorly, tapering to an obtuse anterior apex, subcylindrical, slightly compressed, the length twice to two and one-half times the breadth, a hemispherical sarcode bubble usually present on the left hand dorso-lateral border; cuticular cilia long, fine, setose, a single postero-terminal seta usually distally curved; oral aperture ciliated, remote from the anterior apex, placed at the posterior termination of a shallow, narrowly ovate, ciliated, adoral groove centrally and longitudinally traversing three-fourths of the ventral surface, and bearing on its right hand margin a flexible comb-like appendage composed of large, coarse, non-vibratile cilia, thickened distally and diminishing in length as they approach the oral aperture, which they surround; the adoral groove also bearing near its left hand margin a row of long, fine, vibratile hairs, and throughout its entire length a series of long, vibratile cilia, somewhat fascicled anteriorly and shortening as they approach the mouth; contractile vesicle single, sub-terminally located near the right border; nucleus ovate, mesially placed in the anterior body half; trichocysts large, straight, apparently prismatic, tapering to an obtuse point, and bearing distally two or more minute, radiating, linear processes. Habitat: Fresh water, with Lemna. Length of body $\frac{1}{100}$ inch.

The animal was studied with a homogeneous immersion $\frac{1}{10}$ by Herbert Spencer, N. A. 1.35, and a homogeneous immersion $\frac{1}{8}$ by Bausch and Lomb, N. A. 1.43, two objectives which are really works of art.

THE THEORY OF SEX AND SEXUAL GENESIS.

BY C. M. HOLLINGSWORTH.

IN sexual genesis the germinal aggregate with which the development of the new individual begins is the product of the union of two generative cells. One of the combining cells—the female element, or germ-cell—is a very large one; while the other—the male element, or sperm-cell—is a very small one. Their union is effected by the sperm-cell, or its generative matter, penetrating into the body of the germ-cell; and the former loses its identity and integrity as a cell in the act of union, while the latter does not. Sexual genesis, in its initial stage, is thus a dual process, consisting in the coöperation or combined action of two factors, and these factors are comprised in the contents of generative cells that are morphologically distinct.

The fundamental problem in the theory of sexual genesis, with regard to the physiology of the process, is this: Are the two factors of the process represented in these two classes of morphologically distinct generative cells likewise functionally distinct, and complementary the one of the other? And, if so, What are the physiological differences between them, and what the need and rationale of their observed mode of coöperation in the generative process?

Besides explaining the physiological differences and relations to each other of the male and female generative elements, an adequate theory of sex and sexual genesis must also explain the correlated morphological and functional differences between male and female organs or organisms.

The Advantage of Genesis by Germ-cells.—The development of an individual organism may begin with the contents of a single generative cell, which may or may not be the product of the union of two cells, or it may begin with a bud or gemma composed either of an aggregate of untransformed cells or of portions of partially differentiated tissues. Leaving out of consideration for the present the fact that in sexual genesis the original contents of the germ-cell requires impregnation by a sperm-cell in order to enter upon the normal developmental changes, I wish here to point out that the former mode of the origin of new individuals gives an important advantage in the perpetuation of species, so far as perpetuation depends on the production of a great number of off-

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spring. The explanation of this advantage may be given as follows: In order that a germinal aggregate may develop into a distinct individual, with a due coördination of its parts about a distinct axis or center, the formative conditions within it must first be, in some manner and to a great extent, isolated from the formative conditions in the parts of the parent-body in connection with which its production as an aggregate has taken place; otherwise its unity of development as a distinct individual would be interfered with, or we may say would be impossible. For this reason the size which a bud is required to have in order to enter upon an individual development is much greater than the size which a germ-cell is required to have. This follows from the manner in which a bud is formed. In the simplest case for multicellular organisms, a bud is formed by the outgrowth by cell-multiplication of an aggregate of cells from a layer of undifferentiated cells of the parent body. Thus in the first stages in the growth of the bud, both the cells which compose it and the cells of the layer from which it is produced, must be in a plastic, formative state in order that the growth of the bud in this manner may go on. And the isolation that is requisite to its distinct individual development is only brought about by sheer outward growth away from the producing cell-layer. That is, the bud must necessarily, from the mode of its formation, attain considerable dimensions before its independent development can begin.

On the other hand, where the development begins with the contents of a single germ-cell, the requisite isolation of the formative conditions within it is brought about, not by growth in size, but by the germinal mass becoming inclosed by a distinctly differentiated cell-wall, or capsule, or embryo-sac. And thus, as in the higher plants, we find that the first stages in the development may take place with the new individual completely inclosed on all sides with tissues of the producing organism in which vital processes are actively going on. This surrounding tissue itself forms a small bud, but one of low organization and generally much smaller than any bud that is fitted for functions of self-maintenance. The eggs of animals in like manner become isolated in their formation, but are discharged from the producing organ before their development begins.

In consequence of these relations an immensely greater number of seeds or eggs fitted for a complex development can be

produced by a plant or animal than of bulblets or gemmæ. Moreover, when produced they are better adapted for dispersal, in the case of seeds, to suitable situations for their growth; and in the case of eggs, may be deposited in favorable situations by the producing animal.

This advantage of genesis by germ-cells over genesis by the production of buds, obtains in all the lower grades of organisms in which the perpetuation of species depends, to a great extent, on the production of a large number of offspring. For the higher animals, or for all terrestrial animals, there is the further consideration that the large buds which they would have to produce, and the mode in which they would have to produce them in order to keep up the succession in this way, would so encumber the producing organism as greatly to lessen its powers of self-conservation. As a matter of fact we do not find any terrestrial animal reproducing by buds. The highest aquatic animals that do so are the Tunicata or Ascidians. In these the buds are produced from a large stolon, which the medium in which the animal, or associated group of animals, is supported, enables it to carry with it without any great interference with its self-conservative actions. Besides, in the aquatic mode of life the whole body may be soft, and that high degree of differentiation of the tissues is not required, at least in all cases, that is required in terrestrial animals. But all animals and plants, except the lowest, that reproduce by the formation of buds, also reproduce from germ-cells. In such cases, to whatever advantages the former mode of genesis has in keeping up the succession, is added the advantage, here pointed out, which attends the latter mode.

The Rationale of Sexual Genesis.—Admitting that there is an advantage, of the kind above explained, attending genesis by germ-cells, in the perpetuation of species, the further question arises, of what the advantage or need is of the addition to the original contents of the germ-cell of the matter of a sperm-cell, in order that the single mass may be fitted to initiate the development of a new individual. No doubt a considerable advantage results from crossing. But crossing does not always take place in sexual genesis. Besides, to assign this reason is not to give a fundamental explanation. It leaves the physiological difference between the two kinds of generative cells to be determined, and the requirements of the formative and developmental processes to be assigned which makes this difference necessary.

The germ-cell and the sperm-cell cannot be regarded as physiological or generative equivalents—leaving out of the account for the present their morphological characters. They are physiologically differentiated, though not specialized in the sense in which the component cells of the various tissues are specialized. It is the function of the cells of each of the different kinds of tissues, as specialized cells, to form or secrete from substances derived from the general plasma of the organism, some organic compound of specific constitution, which is either deposited in contact with the protoplasm of the cell as a solid or semi-solid component part of the structure of the tissue, or is thrown out as a liquid secretion by the bursting of the cell-wall. The functions of the two kinds of generative cells are not such that their differentiation from each other could be of a nature to render them specialized in this sense. But since the office of sexual genesis consists in the production of organisms as wholes, and not merely of limited parts of organisms, we may fairly infer that in so far as the developmental process in general can be analyzed into two essential factors, it is these two factors which constitute the organic basis of the dual character of the function of sexual genesis, and therefore that it is with reference to these two factors of the process that the two kinds of generative cells have been differentiated, and not with reference to special products of the process. Two such general factors are commonly distinguished by biologists as comprised in and making up the whole process of development, namely, growth and differentiation; or, since cell-division is the basis of differentiation, we may say that in the more strictly formative stage in the development of any organ or tissue, the two factors are cell-growth and cell-division. Hence the presumption on general grounds is, that one kind of generative cells represents one of these factors, or results from differentiation in the direction of one of these factors, and the other kind represents the other factor.

The facts sustained this presumption, and at once indicate to which kind of generative cells each factor in an excessive degree belongs.

Germ-cells attain a greater size than any other formative cells. Says Professor Minot: "It is a rule, no exception to which, I believe, is known, that the mature egg-cell is much larger than any other cells in the body of the parent" (AM. NATURALIST, Feb.,

1880). On the other hand, sperm-cells are among the smallest cells of the producing organism. Mature germ-cells result from the extraordinary growth without division, of certain of the primitive germinal cells of the ovary, generally with the aid of the formative activity of other smaller cells by which they are surrounded. In animals "the spermatozoa are formed by the breaking up of the male germinal cells, or of cells secondarily derived from them by division. The cells which directly give rise by division to the spermatozoa may be called spermospores, and are equivalent to the ova or oöspores" (Balfour, Comp. Embryol., Vol. I, p. 53). Pollen-grains in like manner are produced by the subdivision of a mother-cell. In all except "the lowest forms of vegetable life * * * the two cells that take part in the act of sexual union * * * are strikingly different in size, form and physical properties. In these cases one of the two cells, the male cell, conveys to the other only a small quantity of material by means of which it produces an effect upon it; this other cell, the female cell, contains by far the largest proportion of the material which takes part in the development incited by the act of union" (Sachs, Botany, p. 224).

Thus in the production of germ-cells there is evidently a relative preponderance of the factor of growth; and in the production of sperm-cells there is a relative preponderance of that factor of the developmental process which is more especially concerned in cell division.

We have next to inquire why this relation or differentiation between the two kinds of cells should be necessary to their coöperation in the initiation of a complex development.

A germinal aggregate which is fitted to initiate the development of a complex organism must be an aggregate of considerable size, in order that it may afford an adequate basis for the incipient formation of the different parts. The production of such an aggregate can only take place on condition of the absence of a tendency in it to undergo segmentation, and thus enter upon developmental changes while it is yet small. It must be so constituted and so placed that there is a relative deficiency of the factor of cell-division in the formative processes by which it is produced. Then, when it has attained the requisite size, it is still unfitted for active development until this deficiency is supplied, and the proper balance between the two factors is restored.

This result is brought about by the accession to it of a sperm-cell, which represents a relative preponderance of the factor of cell-division, and the development is then begun with that degree of energy which is necessary to insure its going on to completion. In every species of organisms a certain mean adjustment of these two factors to each other is suitable to the formation of organs and tissues having the requisite structural characters, after the first stages of the development have been passed through. In the germ-cell there is a departure from this mean standard of adjustment in one direction, and in the sperm-cell a departure in the opposite direction; the departure in the one case being necessary to the formation of a single aggregate of sufficient size to serve as the basis of the development, and the departure in the other case being necessary to the formation of germinal matter fitted to restore the balance by its union with the larger aggregate. This I believe to be the fundamental principle in the theory of sexual genesis.

But in parthenogenesis the germ-cell undergoes development without impregnation by a sperm-cell; and at first it may appear that the theoretical conclusion here arrived at is irreconcilable with this fact. It may be shown, however, that it is not. In the first place, parthenogenetic eggs or germ-cells are generally smaller than eggs that require fertilization. In the second place, whether they are smaller or not, the individuals developed from them do not generally if ever attain to as high a grade of organization as those developed from impregnated germ-cells. So conspicuously is this the case in plants, that Sachs bases his interpretation of the phenomena and advantage of sexual genesis on this observed difference. In the third place, the normal balance between the two factors of the developmental process may be restored in the germ cell, but not so completely, in other ways besides impregnation by a sperm-cell. This may result from a freer access of oxygen to it after it has been discharged from the producing organ; by its absorption of water, with other matters in solution, which have a tendency to set up active changes within it; or by its being subjected to a higher temperature than that at which it was kept during its formation. By one or another or all of these changes of conditions the balance may be sufficiently restored to cause the development to go on; but not so completely restored as it is by the accession to the germ-cell of a

sperm-cell, in addition to changes in some of the external conditions here mentioned. And in sexual genesis there is the further difference that whatever advantage there is in crossing, or in the union of two portions of germinal matter derived from different sources, is also secured.

The Redundant Sexual Type.—In the early stages of embryonic development in the higher animals no distinction as to sex is apparent even in the sexual organs. Having regard to this fact, the view which had come to be generally accepted among physiologists, before the advent of Darwin's theory, with respect to the morphology of the sexes, was, that there is a common type for all the individuals of both sexes in a species. But by most physiologists this type was not believed to be hermaphroditic. "The early type of the sexual organs is to be regarded as common and single rather than double, as some have considered it" (Allen Thomson, Todd's Cyclop., Vol. II, 1839, Art. Generation). In the article on hermaphroditism in the same work, Simpson adpots, as he says, "the opinion commonly received by physiologists of the fundamental unity of sex among all individuals belonging to the higher animals; or, to express it otherwise, we have assumed that each individual is, when normally formed originally furnished with elemental parts capable of forming one set of sexual organs only." Still he refers to the rudimentary sexual organs in each sex as analogues of developed organs in the opposite sex. The most familiar and striking examples we have of such rudiments are the rudimentary mammæ in male mammals and the clitoris in females.

When Darwin adduced the existence of rudimentary organs as evidence in support of the theory of descent, and as facts that are inexplicable on any other theory, he made no distinction between rudimentary sexual organs and rudiments of organs that pertain to individual self-maintenance. The only possible or reasonable explanation of the existence of the latter is that they are reduced representatives of organs that were functional in the ancestors, in some former period, of the organisms of the present time in which they are found. And the same explanation was applied by Darwin to the rudimentary sexual organs—which explanation has generally been adopted by his followers. But against this explanation in the case of the sexual rudiments two valid objections may, I think, be made. In the first place, none of the

highest animals of the present time are functional hermaphrodites. Says Gegenbaur: "The hermaphrodite stage is the lower, and the condition of distinct sexes has been derived from it. This change is due to the decrease in size of one or the other organ, so that hermaphroditism is the precursor of sexual differentiation. This differentiation, by the reduction of one kind of sexual apparatus, takes place at very different stages in the development of the organism, and often when the sexual organs have attained a very high degree of differentiation. In these cases ontogeny exhibits the two kinds of organs primitively united, and so causes the individual to be hermaphrodite at a certain stage in development" (Compar. Anat., Eng. ed., 1878, p. 54). But this general hypothesis becomes inconsistent with the facts when carried out in its application to the higher vertebrate animals. It is in the highest animals that the most perfectly formed rudiments are found, in each sex, of the sexual organs that in their developed or functional state are proper to the opposite sex alone. If they are reduced representatives of organs that were once functional, those organs must have been functional in animals of the same grade and type as those in which the rudiments are now found; otherwise the rudiments would not be the exact analogues or reduced representatives which they are, of the functional organs at the present time of the opposite sex. And no physiological reason can be assigned why animals in other respects of the same type and grade of organization, which are best fitted to perpetuate their species by a complete functional differentiation of the sexes, at the present time, should have been better fitted to do so as hermaphrodites at a former period. In the second place, the whole morphological type of the reproductive organs of either sex in any species of the higher animals, comprising both rudimentary and developed sexual organs, does not make up a full complement of the developed sexual organs of both sexes. Referring to the higher animals, Simpson says: "An hermaphrodite was defined by the ancients as an individual capable of fulfilling by turns the reproductive functions of both sexes, or at least one who simultaneously possessed both the male and female organs fully developed; such a being, however, is not only unknown among the authentic details of anomalies, but is physically impossible in man and the higher orders of animals without extensive alterations in the connections of the bones and

other parts of the pelvis. "The type of development [from common embryonic parts] of the genital organs may be stated to differ in the different parts of the system in the two sexes as follows:

"1st. It is single and homological in the external organs.

"2d. It is double and heterological in the middle organs or passages.

"3d. It is partially double and heterological in the productive organs" (Quain's Anatomy, 1876, Vol. II, p. 814).

The morphological sexual type of either sex comes thus short of comprising a complement of the developed organs of both sexes, owing to the fact that for some of the organs, or parts of the sexual apparatus, the same primary tissue develops into a male organ or part, in one sex, and into a female organ or part in the other sex. But the common fundamental type of the species is redundant as to the number of organs required to be developed in either sex alone, owing to the fact that for some of the organs the same primary tissue that is required for functional parts, in one sex, cannot be converted into functional parts in the other sex. In the higher animals, therefore, the normal development of each male or female individual is a one-sided development of this sexually redundant type, and not a one-sided development of an embryonic hermaphrodite.

Thus much premised, two questions of theory have to be answered in order to make all the phenomena of sexual development intelligible. We wish to know why it is that useless rudiments appear in one sex of organs that are only required to be functional in the other sex; and we wish to know how it is that, except in rare cases, each individual, presenting at first the common embryonic type of the whole species, afterward undergoes complete development in the adult sexual characters of one sex or of the other sex alone, and does not take an intermediate course of development between the two adult types.

1. In order that a germ-cell and a sperm-cell may effectively unite in the initiation of the development of a new individual, there must be an approximately complete correspondence between the two as complementary factors of the single course of evolution. There are two conceivable ways in which individual organisms might be produced having the necessary sexual organs of either sex alone fully developed, without rudiments of those that are functionally proper to the other sex being formed. One way

would be for each female parent organism to produce two kinds of ova or germ-cells, one kind fitted to initiate the development of male, and the other the development of female offspring, while each male parent organism produced two corresponding kinds of sperm-cells. The other way would be for only one kind of ova and one kind of sperm-cells to be produced in a species, but for each embryo to be deflected to a one-sided development—that of one of the sexes—so early and so completely that no perceptible rudiments of the sexual organs proper to the opposite sex should at any time be formed. The first method is evidently too complicated ever to be established and maintained in any species by natural selection, at least without some great advantage in the perpetuation of the species could be gained by it that could not be secured in any other way. The second method is actually exemplified in a great many of the lower monosexual organisms, where the requisite sexual organs consist simply of an ovary or pistil in the one sex and a testicle or anther in the other. In these no persistent rudiments of the organs of the opposite sex are perceptible in individuals of either sex. But in the higner animals, where a complicated apparatus in intimate correlation with the other parts of the body is required in each sex for the performance of its part of the reproductive function, so early and complete a deflection of the course of development, with respect to these organs, cannot take place. A certain set of sexual organs of the sexually redundant type must be developed to a functional state in each sex; and the intimate structural connection and functional coördination with the other parts of the body demanded in the efficient performance of their functions, makes it necessary that their development be initiated at an early stage in the development of the embryo. But an organism of great complexity can be evolved only on condition that the parts of the embryo shall not become highly differentiated in the early stages of the evolution—on condition that the various parts of the forming body retain for a considerable time their plasticity. In its early stages, therefore, the embryo, considered as a conditioning apparatus of its own formative processes, is necessarily unfitted to have established, or maintained within it, so sharp a differentiation of the conditions of those processes, as affecting the development of the sexual organs, as would be necessary to cause those organs that are functional in either one of the sexes only to enter upon a complete development, and at the same

time cause the development of the organs that are redundant to that sex to be so completely arrested that not even rudiments of them should appear. This explanation agrees with and also explains a law of variation enunciated by Darwin, namely, that "variations which appear early in life in either sex, tend to be developed in both sexes" ("Descent of Man," p. 232).

The existence of rudimentary sexual organs is thus, I think, satisfactorily accounted for, without assuming that they represent organs that were once functional in the sex in which they are found. In the course of descent of a species it is the common type of the species—which is redundant as regards the organs that are required to be functional in either one of the sexes—that undergoes modification by adaptive variation, and by the natural selection of irrelative variations through the succession of the best reproducers. Those organs of the redundant type that are functionally proper to either one of the sexes have their characters determined by natural selection acting within that sex. But if, owing to the conditions above explained, a developed organ in one sex is represented by a rudiment in the opposite sex, any modification of this part of the common type will not only appear in the developed organ of the one sex, but also and correspondingly in its rudiment in the opposite sex. Thus, for the higher animals at least, the rudimentary sexual organs are to be regarded as having been acquired *as rudiments* in the sex in which they are found, and not as representing organs that were once functional in that sex. This explanation accords with the fact that such rudiments are most perfectly formed in the highest animals, where the developed sexual organs themselves attain the highest degree of organization as specialized parts.

No doubt there are cases among plants in which the reproductive individuals, or members of a composite individual, are now unisexual, and possibly among the lower animals also, where rudimentary sexual organs do represent organs that were functional at a former period, when the species was hermaphrodite. But in many cases it would be difficult to determine whether the actual course of modification by which the present reproductive type of the species has been reached, has been by the reduction of organs that were once functional to a rudimentary state, or by the acquisition of the rudiments as parts of the common reproductive type of the species.

(To be continued.)

ON THE EVIDENCE THAT THE EARTH'S INTERIOR IS SOLID.

BY DR. M. E. WADSWORTH.

(Continued from page 594, June number.)

The Evidence of the Earth's Solidity derived from the behavior of matter under the combined action of Heat and Pressure.—The key-note of this problem was given by Mr. William Hopkins in stating that if the tendency of the temperature to liquify the interior portion of the earth increases more rapidly than the pressure tends to solidify it, that interior would be in a state of greater or less perfect fluidity; but if the tendency to solidify from pressure is greater than the tendency of the temperature to prevent it, the earth would solidify from the center. In other words, whether the earth's interior is solid or not, depends upon the relative increase of the temperature and pressure, and on the behavior of the earth's materials under increased heat and pressure. Some experiments were made by Hopkins to ascertain the relation of solidity and fusion under the combined influence of heat and pressure on certain substances. He found that for spermaceti, wax, sulphur, and stearine as the pressure increased the point of fusion was raised, but irregularly, and with a diminished ratio, while metallic alloys showed no elevation of the fusion point. He did not regard his experiments as satisfactory, particularly those on the alloys.[1]

The subject was later discussed by Sir William Thomson, who held that from the "thermo-dynamic law of his brother, James Thomson, the earth must have solidified from the center outwards. This law asserts that all materials which contract on congelation have their melting point raised by pressure, while bodies that expand on freezing have their melting point lowered by pressure.

This law was experimentally verified by Wm. Thomson in the case of water. Hence, accepting Bischof's experiments as correct, which indicated that the earth's materials contracted from ten to twenty-five per cent on solidification, Thomson claimed that even if the internal heat was very great, the pressure would increase more rapidly than the tendency to liquify, and hence the earth must have a solid center.

The discussion then rests largely on the question of fact: Do

[1] Report Brit. Assoc., 1854, XXIV (Sect.), 57, 58; see also Bunsen, Ann. Physik Chemie, 1850, LXXXI, 562–567.

the earth's materials contract or expand on solidification? Mousson experimented further on the action of water according to James Thomson's law, and showed that it required enormous pressure to lower the melting point of ice a few degrees.[1]

So far then as any conclusion can be drawn from these experiments, it would show that the pressure must increase to an enormous amount to keep pace with the supposed increase of heat—a pressure that the earth's specific gravity negatives.

It can well be claimed that the known rate of the elevation of temperature, as the interior is approached, far surpasses the known rate of change of the fusion point by pressure in the few cases investigated.

David Forbes has further pointed out that, since the substances mainly experimented upon by Hopkins and Bunsen are not, except sulphur, components of the earth, experiments made with them do not necessarily apply to the materials of which the earth is composed. He also suggested that if the pressure is raised to great heights the reverse may be true regarding the effect of pressure on the melting point—it may lower instead of raise it. He also thought that we should look rather at the results obtained by Hopkins from the alloys instead of those from the wax, etc.[2]

In discussing the state of the earth's interior, Dr. T. Sterry Hunt advanced the argument that the material of the earth, when in its former fused state, would solidify from the center on account of the congealed mass being much heavier than the liquid: "We may say in a few words that the process of cooling in a mass like this would be just like the cooling of a great bath of metal or of sulphur; in other words, the condensation or congelation would commence at the center and extend outward toward the surface, so that the temperature of the center would therefore be the temperature of congelation."[3]

David Forbes, in reply to Dr. Hunt's argument, very pertinently remarked that no one "had ever seen a mass of metal or sulphur crystallize or solidify in the interior first, since the interior of such masses, it is well known, remain liquid after the

[1] Ann. Physik Chemie, 1858, CV, 161–174; Everett's Deschanel's Natural Philosophy, 1872, pp. 312, 313; 1883, pp. 331, 332.

[2] *Pop. Sci. Rev.*, 1869, VIII, 121–130; *Geol. Mag.*, 1867 (1), IV, 431–444.

[3] *Geol. Mag.*, 1877 (1), IV, 357–369.

crust has formed upon the surface; and furthermore, that the crust always remains upon the surface and does not sink."

He also remarked that "a crust of the specific gravity of 2.65 cannot sink deep down into the fluid mass of a globe possessing the mean density of 5.3."[1]

In looking over the data for the assumed contraction of the materials forming such portions of the earth's crust as we are able to examine, it will be seen that the early experiments of Bischof indicated a contraction in passing from the liquid to the crystalline state for basalt of some ten per cent, of trachyte eighteen per cent, and of granite twenty-five per cent; or tabulating the results, we obtain, according to David Forbes:[2]

	VOLUME.		
	Fused.	*Glass.*	*Crystalline.*
Basalt	1000	963	896
Trachyte	1000	888	818
Granite	1000	888	748

The question of the contraction of igneous rocks in cooling, was further taken up by David Forbes,[3] although none of his observations appear to lead to any more definite conclusions than that Bischof's results were much too high, and that his work was too crude to be of any great value.

In a later paper Forbes pointed out that in nature there was no evidence of a contraction of from one-tenth to one-quarter of the volume, such as Bischof had held, when the rocks in the form of dikes, etc., were studied *in situ*—a statement that probably every petrologist will sustain.[4]

Some further experiments on the contraction of siliceous materials in cooling were made by Robert Mallet. He claimed that the result showed "that the difference in specific gravity, less than that between ice and water, between red-hot but solidified or even cold slag (or analogous fused rocks) and the same in liquid fusion, is so slight that, coupled with the viscous or pasty condition which intervenes between the two states, it would readily admit of a thin or a thick terrestrial solidified crust being supported by and upon the surface of the liquid globe beneath, and

[1] *Geol. Mag.*, 1867 (1), IV, 431–444; *Chemical News*, 1868, II (Amer. reprint), 110–113.

[2] Neues Jahr. Min., 1841, pp. 565, 567; 1843. pp. 1–54; *Chemical News*, 1868, XVIII, 191–194.

[3] *Chemical News*, 1868, XVIII, 191–194.

[4] *Geol. Mag.*, 1870 (1), VII, 1–4.

lends no support to the view of terrestrial consolidation at the center first, by continual subsidence of such crusts, as imagined by Poisson, nor to the notion as to the nature of volcanic action which Sir W. Thomson has based on that assumption. * * * We * * * may be permitted to conclude that rocks consisting of acid silicates contract still less than those of basic silicates, and that a terrestrial crust of the former is still more capable of floating upon the same in fusion beneath."[1] However much Mr. Mallet's views may agree with those of the present writer, it is but just to point to the fact that the slags experimented upon differ essentially from basaltic rocks, and it is not permissible to assume that one certainly gives the law for the other, however probable it may be that they act alike under similar conditions. This also applies in less degree to Mallet's comparison between plate glass and the rhyolites.

Further studies were made, in 1874, by Mr. Mallet on the alleged expansion of various substances on solidification. His experiment of filling a conical wrought iron vessel with molten iron seemed to show that liquid iron when heated far above its melting point has a specific gravity of 6.65, while the same iron in the cold state is 7.17. Mallet claims, therefore, that cold cast-iron is always heavier than molten iron. It is to be observed that no comparison was made between iron near the melting point and the same when just above that point.

He further tried some experiments regarding the flotation of solid iron upon molten iron, which must be regarded as conclusive upon that point. In all cases the iron either did not sink, or if when first immersed it sank, it afterwards rose again. Mallet says: "A piece of cold cast-iron which floats on liquid iron of its own quality, if forcibly thrust to the bottom and rapidly and at once released, rises again rapidly to the surface with all the *appearance* of a *buoyant* body, which it certainly cannot be."

The same experiments made with lead showed that it always sank when immersed in the molten lead. In this case when flat pieces were carefully laid upon the fluid lead they floated until the equilibrium was disturbed, so that the fluid could wet the upper surfaces when they sank. This flotation of the lead seems to be a case of the same kind as the flotation of a needle upon water. Mr. Mallet endeavored to explain the phenomena in the

[1] Philos. Trans., 1872, pp. 147–227.

case of iron and lead by the assumption of a repulsive force, much the same kind of explanation as "Nature abhors a vacuum," for here the repulsion exists for iron but not for lead. He seems to have lost sight of the true problem before him: Is solid metal at or near the melting point of a greater or less specific gravity than the same metal liquid at or near the point of solidification, and substituted for it the question is cold solid metal heavier or lighter than the same metal when heated to *any* temperature above the melting point. Surely the tendency of most bodies to expand on the application of heat would, in the case of iron and rocks, cause the difference between the cold solid and the liquid states, to be greater than it would be between the hot solid and the liquid states, a point that does not seem to have been properly appreciated in discussions of the earth's structure. Mallet's experiments show clearly that iron near the point of fusion is lighter than the same when melted, but that lead is heavier. He calls attention to one very important point: That owing to the difference in specific gravity in the various grades of cast-iron, it is necessary that in these experiments the liquid and solid should be of the same quality, otherwise real buoyancy or the reverse may occur from this cause. Mallet further seems to admit that liquid slag will allow solid slag to float upon it, either on account of a certain vesicularity, whatever care may be taken, or on account of his hypothetical repellant force.[1]

Some other experiments were made by Centner, W. J. Millar and Joseph Whitley.[2] The general result of these would be to show that cold steel, iron, brass and probably slag will sink in the same material when molten, but when hot and solid they become lighter and will float; also that lead and perhaps zinc possess a higher specific gravity when solid, whether hot or cold, than the molten metal.

In 1875 Mr. W. C. Roberts made some experiments by Mallet's method, on the density of silver in the cold state and in the molten condition. These showed that it was more dense in the former than in the latter state.[3]

[1] Proc. Roy. Soc., 1874, XXII, 366–368; 1875, XXIII, 209–234; *Nature*, 1874, X, 156, 157.

[2] *Nature*, 1877, XV, 529, 530; XVI, 23, 24; 1878, XVIII, 397, 398, 464.

Whitley's experiments are erroneously credited to Muirhead in Dana's Manual of Geology, 1880, 3d ed., p. 810.

[3] Proc. Roy. Soc., 1875, XXIII, 349, 350, 481–495.

Sir William Thomson in 1878 again took up the discussion of the earth's solidity, based on the assumed greater density of the solid than liquid rock. He seems at that time to have only been aware of Bischof's experiments, but in a note subsequently added by him, Whitley's experiments appear to be accepted as decisive against his views. Starting with the, to him, probable supposition that the solidified crust of the earth would sink towards the center, Thomson says: "As soon as the surface began to freeze, and to freeze in sufficient quantity not to be floated up by mere superficial solidified foam, the mass of rock would fall down towards the center. More would then solidify at the surface. This also would fall down, and the same thing would go on again and again. Gradually a sort of honey-combed solid would be formed. By-and-bye [*sic*] a skeleton or frame-work through the whole would mount up to an extent sufficient to build up piers, as it were, to the surface, and the spaces between these piers, when close enough, would, in the continued freezing of the lava, be bridged across by solid rock thick enough in proportion to breadth not to break down and sink. There would, again, be breaking away of the piers and upheavals of the liquid material below; but by degrees the honey-combed mass would become nearly like a solid throughout with comparatively small interstices of liquid lava. * * * The conclusion to be drawn respecting the internal condition of the earth is, that we are not to infer liquidity of the interior, even if we should find evidence of a much higher internal temperature than that which would melt the rocks under ordinary pressure."

The interior heat, Thomson states, "may be 4000° F., or 5000°. It may possibly be 8000° or 10,000°."[1]

In 1879 investigations were made by Messrs. J. B. Hannay and Robert Anderson on the expansion of cast-iron when solidifying. The chief method used was the flotation of a sphere of cast iron in a molten bath of the same. The latter was cooled near to the solidifying point and then the solid spheres dropped in. "They were found to sink at once when dropped in cold, and they remained under the metal till they had acquired a temperature just approaching visible red; but at that temperature they rose to the surface, and as they gained more and more heat from the liquid metal, their line of flotation rose higher and higher. Some-

[1] Trans. Geol. Soc. Glasgow, 1878, VI, 38–49.

times, if dropped in suddenly, the spheres did not float until they had begun to melt, but this was owing to their having cemented themselves to the bottom of the pot. When dropped in cautiously, or suspended by a wire, they sank only for the space of twenty to twenty-five seconds, and rose to the surface when barely red hot."

These experimenters found that liquid cast-iron expands at least 5.62 per cent of its volume in solidifying. A result that they regarded as under the truth, since the maximum density of the molten iron seemed to be little if any above the melting point, while they were obliged to use it at a temperature above the point of maximum density.[1]

Experiments upon the relative volumes, solid and liquid, of tin, lead, zinc, bismuth, cadmium, antimony, iron and copper have been made by Nies and Winkelmann. These show that tin, zinc, bismuth, antimony, iron and copper in passing from the fluid to the solid state expand; that is, if both the solid and liquid densities of the metals are compared when both are at a temperature near the melting point, the solid has the less specific gravity. Hence these metals when hot and solid would float on the liquid, and pressure, according to Thomson's law, would lower their fusion points, thus they would remain liquid at a lower temperature in the earth's interior than on its surface,[2] a fact which may assist in explaining the eruptive origin of some iron ores.[3]

Further experiments by Messrs. Roberts and Wrightson on bismuth and iron showed that "iron expands rapidly (as much as six per cent) in cooling from the liquid to the plastic state, and then contracts seven per cent to solidity, whereas bismuth appears to expand in cooling from the liquid to the solid state about 2.35 per cent.[4]

From the above detailed experiments and observations it is rendered quite clear that the chief portion of the metals expand in passing from the liquid to the hot solid state, both having their density taken near the melting point. That this is the case with the rocks, also, there seems but little doubt, although further

[1] Proc. Roy. Soc. Edin., 1879, x, 359–362.

[2] Sitz. Akad. München, 1881, pp. 63–112.

[3] Proc. Bost. Soc. Nat. Hist., 1880, xx, 470–479.

[4] *Phil. Mag.*, 1881 (5), xi, 295–299.

careful experiments are needed. Practically this seems to be the case in nature of the Kilauea lavas at least.

The question which now presents itself is: What are the probable components of the earth's interior?

So far as can be told from petrographical study, it appears probable that the portion of the interior mass lying nearest the center, concerning which we have any data, is composed of iron[1] either with or without nickel. As we recede from the central portions pyrrhotite is united with the nickel and iron. Then these minerals are found united with olivine or olivine and enstatite in varying proportions, until a portion is reached composed almost entirely of one or both of these silicates, with or without diallage. This portion passes on into the common basaltic rocks, then into the andesites and so on outward into the trachytic, rhyolitic, and jaspilitic forms.

However true this order may be for the liquid earth, that is, the liquid material would form rocks of this character, it is certain that in the solid portions these materials are interlaced now with one another in every conceivable way, and in the chemical and sedimentary deposits they have now been intimately mingled.

What may be the composition of the earth's mass nearer the center, if there be any, besides the iron and nickel, we have no clue, except that it may be some of the rarer elements now found mixed with the iron.

Now, while we know experimentally almost nothing of the behavior of such materials, as probably compose the earth's interior, under the combined action of heat and pressure, it seems most probable, from Thomson's "thermo-dynamic law" and the experiments on their relative hot solid and liquid densities, that the pressure to which they are subject would cause them to liquify at a lower temperature in the earth's interior than on its surface. It may also be justly claimed that if the earth's interior is solid, its liquefaction may be brought about by an increase instead of a diminution of pressure. In this way a sinking area loaded with sediments might thus liquify the rock beneath it. Is this not as consistent a view as the theory of liquefaction through the removal of pressure?

[1] Whitney's Metallic Wealth of the United States, 1854, p. 434, Judd's Volcanoes, 1881, pp. 307–324.

The best test of the relations in density between molten and solidified rock is apparently to compare the density of the rock just before fusion, or at least near that point, with the density of the same rock after melting. This would give a comparison between the crystalline and liquid states, while the usual method only affords a comparison between the liquid and the glassy or semi-glassy states. It would also save any error arising from cells in the cooled rock, if a solid mass was chosen in the first place. Again the fresh unaltered varieties of a rock should be chosen instead of such old and altered ones as those usually experimented upon.

In all discussions relating to the question of the liquidity of the earth's interior, it is to be borne in mind that the chief portion of our knowledge of the properties of liquids is derived from the study of water, a mobile liquid—while liquid rock, as lava or melted iron, is viscous, and its laws and properties may on experiment be found to differ considerably from those of water, under like conditions. Also in these solids the passage from the solid to the liquid state or the reverse is not abrupt as is the case with water, for every grade of viscosity exists between the normal solidity and the approximately perfect liquid condition. This is especially the case with iron and seems to be so for the common rocks.

(*To be continued.*)

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THE TERTIARY MARSUPIALIA.

BY E. D. COPE.

SINCE Cuvier discovered an opossum in the gypsum of Paris, the knowledge of the Marsupials of the Tertiary periods of Europe and North America has been gradually extended. In Europe they have been traced to the Middle Miocene, when they disappear from that continent. In North America we know them from Oligocene beds (White River), when they disappear, and are only known as yet thereafter as members of the existing fauna. Descending the scale we have them in the Laramie in America and Jurassic in America and Europe, and in the Trias in South Africa. Whether the Triassic Mammalia of the northern hemisphere belong to this order or not is uncertain. Under the head of Creodonta[1] I have discussed the marsupial resemblances of

[1] NATURALIST, March, April and May, 1884.

that division of Eocene mammals, showing that although their dentition is sometimes that of the carnivorous division of the marsupial order, they cannot be placed with them.

The extinct marsupials belong to three types, as distinguished by the form of their superior molar teeth. These are trituberculate, quadrituberculate or multituberculate. To the first division belong the carnivorous types, or Sarcophaga of Owen; to the second the kangaroos and the wombats, to which Owen's name of Poëphaga may be applied.[1] The third division is entirely extinct, and is characterized by having at least three longitudinal series of tubercles in its superior molar teeth. To this suborder I apply the name of Multituberculata. The suborder Sarcophaga includes the opossums, and in North America the single extinct genus Peratherium [2]Aymard. This is also the genus which is found in the Oligocene and Miocene of France. It differs from Didelphys (the true opossum) in the non-inflection of the angle of the mandible. Otherwise the two genera are very similar, agreeing in the number (eight) of the inferior incisor teeth. Five species have been found in the White River beds of Colorado. The largest of these, *P. fugax* Cope (Fig. 1), had the skull as large as that of a mole (*Scalops aquaticus*). The smallest, *P. huntii* Cope, does not exceed a small shrew in dimensions.

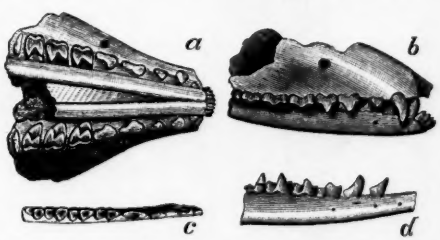


FIG. 1.—*Peratherium fugax* Cope, from the White River beds of Northeastern Colorado, twice natural size. Fig, *a*, anterior part of skull from below; *b*, do. right side; Fig. *c*, part of right mandibular ramus, with all the molars or their alveoli, from above; *d*, do., from the right side.

Of Poëphaga no extinct forms have been found in North America.

The Multituberculata include three families, which differ as follows:

Fourth superior premolar (at least) like true molars..... *Tritylodontidæ.*
Fourth premolars (and probably others) more simple than first true molars
Polymastodontidæ.
Fourth premolars (and often others) developed into flat cutting blades
Plagiaulacidæ.

[1] Owen places the Phascolomyidæ in a distinct suborder, but, as it appears to me, without sufficient reason. [2] Bulletin U. S. Geol. Survey Terrs, V, No. 1, p. 45.

In all three of these families the incisor teeth are in reduced numbers, and are constructed on the rodent type, with an external band of enamel. They thus approach the genus Phascolomys (wombat), one of the Poëphaga of the existing Australian fauna. The genus Tritylodon (Fig. 2), recently described by Owen, is from the South African Trias. It is a remarkably specialized form, considering its geological antiquity. Its formula above is, I. 2; Pm. 4; M. 3. The lower jaw is unknown. The median incisors are developed at the expense of the laterals, and are separated by a wide interspace. There is also a maxillary diastema. The molars and last premolars all support three rows of shortly conic tubercles (Fig. 7 *h*). The genus Stereognathus

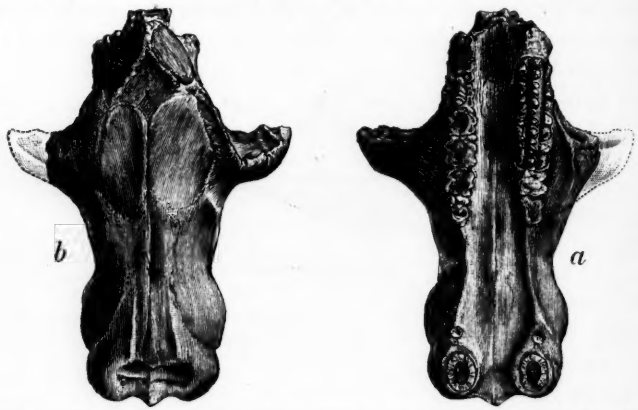


FIG. 2.—*Tritylodon longævus* Owen, anterior part of skull, natural size; from the Triassic beds of S. Africa. Fig. *a*, from below; *b*, from above. From Owen, Quart. Journ. Geol. Society, 1884, p. 146.

Charlesw., includes species from the English Oölite. The known molars have three longitudinal rows of crescentic tubercles (Fig. 7 *b*). The species are no larger than a small shrew, while the skull of *Tritylodon longævus* is as large as that of a gray fox. Information as to the structure of the skeleton of these remarkable forms has not yet been obtained.

There is but one genus of the Polymastodontidæ, the Polymastodon Cope. It is known from three species, all from the Puerco Eocene of New Mexico. The largest, *P. taoënsis* Cope, has bones equal in size to those of the large kangaroo, *Macropus major*. The jaw of the smallest species, *P. foliatus* (Fig. 5), is as large as that of *Hyrax capensis*; that of the third species, *P. fissidens*

Cope, is intermediate in dimensions, and the dentition has some well-marked peculiarities. The characters of the skeleton, so far as known, are derived from the *P. taoënsis* (Figs. 3 and 4).

The angle of the lower jaw is inflected, and the dental foramen is at the anterior apex of a large fossa, as in most marsupials. There are but two true molars in each jaw, and a single simple premolar, below. The condyle of the humerus presents characters shared by Meniscoëssus of the Laramie, which are found in lizards. There is a strong and thick intertrochlear ridge in front, which is so swollen at one side of the middle line as to resemble the condyle

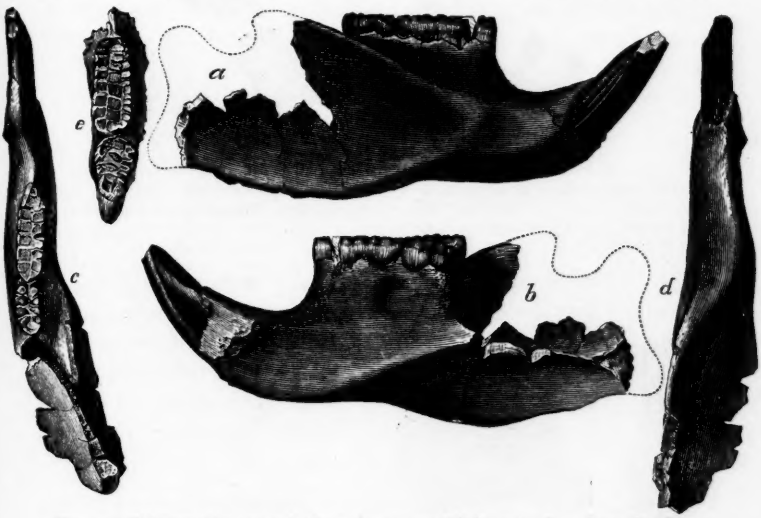


FIG. 3.—*Polymastodon taoënsis* Cope, jaws, two-thirds nat. size; from the Lower Puerco beds of New Mexico. Fig. *a*, right mandibular ramus right side; *b*, do., internal side; *c*, do., from above; *d*, from below. Original, from Report U. S. Geol. Survey Terrs., F. V. Hayden in charge, Vol. III.

of a femur. The trochlea for the coronoid process of the ulna, on the posterior side, is narrowed so as to suggest a rotular groove (Fig. 4*b'*). The humeral cotylus of the ulna is adapted to this condyle by a flare on each side (Fig. 4*c*). The astragalus is without trochlea, as in most Puerco Mammalia, and the trochlear portion is gently convex anteroposteriorly. The head is much narrowed, and has a narrow navicular face which is convex in only one, the vertical, direction. On its outer side it bears a large flat facet for the cuboid bone (Fig. 4*d'*). This form is much like that of the kangaroos. It shows that the peculiar structure of the posterior foot of the Macropodidæ already existed at this early day, though

perhaps in not quite so specialized a condition as at the present time. The form of the astragalus shows that the internal digits

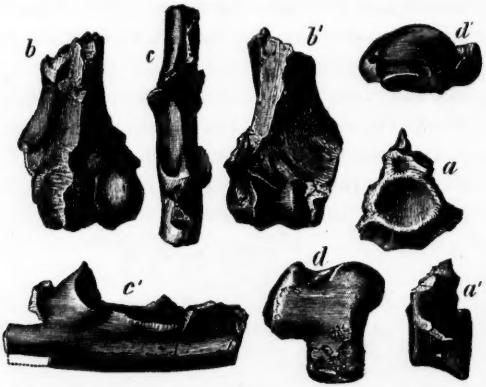


FIG. 4.—*Polymastodon taoënsis* Cope; parts of individual represented in Fig. 3, two-thirds nat. size. Fig. 4*a*, caudal vertebra, front; *a'*, do., left side; *b*, humerus, distal portion, front; *b'*, posterior side. Fig. 4*c*, ulna, proximal part, front side; *c'*, from above. Fig. 4*d*, astragalus, from above; *d'*, do., from external side. Original, from Report U. S. G. Survey Terrs., F. V. Hayden in charge, Vol. III.

are of very reduced size, the first probably wanting, in Polymastodon, and that the external digits were large and constituted the principal agent in progression. That the animal had a large tail is proven by the few caudal vertebræ preserved (Fig. 4*aa'*).

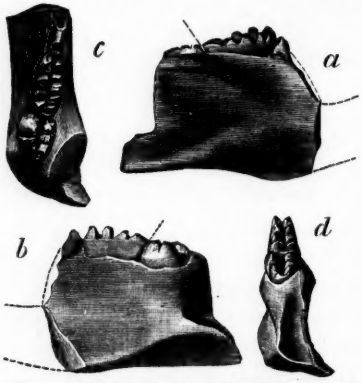


FIG. 5.—*Polymastodon foliatus* Cope; part of right mandibular ramus, natural size, Fig. 5*a*, right side; *b*, left do.; *c*, from above; *d*, posterior view, showing masseteric and dental fossæ. From the Lower Puerco of New Mexico. Original, from the Report of the U. S. Geol. Survey Terrs., F. V. Hayden, Vol. III.

The inferior molars have but two rows of tubercles, and the penultimate is much larger than the last one. The former tooth looks a good deal like a reduced last inferior molar of some species of Mastodon. The family was of herbivorous habits, and is probably the ancestral type of the kangaroos. The discovery of this remarkable genus in our Lower Eocene beds marks an important advance in the knowledge of the origin

of one of the most interesting of living forms. On the other hand, the Polymastodontidæ may well have derived their origin from the Tritylodontidæ, which were also of herbivorous or granivorous habits. The family of the Plagiaulacidæ[1] is one of the most peculiar among those of the Mammalia, whether we consider its structure or its relations to geological time. Commencing in the Jurassic period, it persisted through the Cretaceous to the Eocene. It then disappeared from view to remind us once more of its existence by its probable descendant, the extraordinary pouched lion of the Pliocene period of Australia, *Thylacoleo carnifex* Owen (Fig. 9). The family exhibits the usual successional relation of its component genera. In this respect it repeats what I have already pointed out as a law of succession in placental Mammalia,[2] a reduction in the number of premolar teeth. The following table exhibits these relations:

I. Tubercles of superior molar crescentic.
Fourth premolar serrate, not ridged ..... *Meniscoëssus.*
II. Tubercles of molars subconic.
a. Four compressed premolars below.
Premolars serrate, not ridged ..... *Ctenacodon.*
Premolars ridged and serrate ..... *Plioprion.*[3]
aa. Three compressed premolars.
Premolars ridged ..... *Plagiaulax.*
aaa. Two premolars.
Fourth premolar ridged ..... *Ptilodus.*
aaaa. One premolar.[4]
Fourth premolar ridged ..... *Neoplagiaulax.*
Fourth premolar smooth ..... *Liotomus.*[5]

Of these seven genera but nine species are thus far known. Ptilodus and Ctenacodon have two species each; and each of the others but one. Ctenacodon, Plagiaulax and Plioprion are Jurassic; Meniscoëssus is Cretaceous, and the remaining three genera are Eocene Tertiary. The American genera are Ctenacodon Marsh (Fig. 7 *g*), Meniscoëssus Cope, and Ptilodus Cope. The first named is the most generalized of the family. The *Meniscoëssus conquistus* Cope, has the distinction of being the only known mammal of the Cretaceous period.

[1] This family is the equivalent of Marsh's "order" Allotheria.
[2] Bulletin U. S. Geol. Survey Terrs., VI, p. 168.
[3] Gen. nov., type *Plagiaulax minor* Falconer.
[4] Number unknown in Liotomus.
[5] Gen. nov., type *Neoplagiaulax marshii* Lemoine.

The genus first discovered was the Plagiaulax of Owen, of which the typical species was found in the Purbeck bed of the Isle of Wight, England. It was made the subject of a memoir by Falconer. Ctenacodon was next discovered in the Jurassic of Wyoming by Marsh in 1879. In 1880 Dr. Lemoine discovered the first Tertiary representative of the family, and in 1882 named it *Neoplagiaulax eocænus* (Fig. 6). In November, 1881, I described the first American Tertiary form, which was discovered in the Puerco beds of New Mexico, under the name of *Ptilodus*

FIG. 6.—*Neoplagiaulax eocænus* Lemoine, from the Cernaysian beds of Reims, France; mandibular rami and teeth of three individuals which are represented by the letters *a*, *b* and *c*. Figs. *a*, *b*, and *c*, much enlarged. Figs. *a'*, *b'* and *c'*, natural size. Fig. *b'''*, from above. From Lemoine, Bulletin de Soc. Geol. de France, 1882, p. 249.

mediævus (Fig. 8). Its presence in that formation, together with various other associated types, proved the near homotaxy of the beds explored by Dr. Lemoine near Reims with those of New Mexico.[1]

Up to this time the great Cretaceous period had remained a blank in the history of Mammalian life. European palæontologists had examined the fresh-water beds of this period for mammalian remains without success. Among them, the gifted Kowalev-

[1] See the NATURALIST, 1883, p. 870.

sky, too soon lost to science, spent much time in the south of France among the formations which most nearly represent the American Laramie formation, but found no Mammalia. It remained for Mr. Wortman to crown a series of successful expeditions by the discovery of the *Meniscoëssus conquistus* in the Laramie formation of Dakota, its loose teeth being found mixed with the teeth of dinosaurs and scales of gar-fishes. The characters of the molar teeth are highly appropriate to the geological age of the genus, the superior molar resemblinhg bot that of the Jurassic Stereognathus and the Eocene Polymastodon.

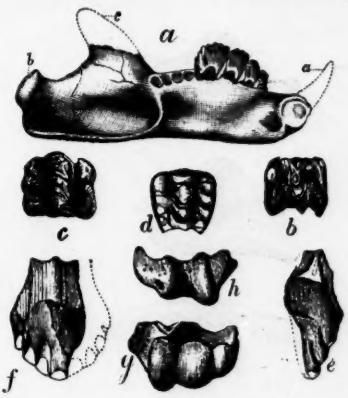


FIG. 7.—Fig. *a*, *Ctenacodon serratus* Marsh, ½ nat. size, from Marsh. Fig. *b*, molar of *Stereognathus oöliticus*, ¾, from Owen. Fig *c*, right fourth upper molar of *Tritylodon longævus*, from Owen, ¾. Figs. *d–f*, *Meniscoëssus conquistus* Cope, ¾ nat. size. Fig. *d*, superior molar; Figs. *e–f*, superior fourth premolar[1]; *g*, humeral condyles of a smaller species with jaw, found with the *Meniscoëssus*.

I have shown that the cutting tooth of the lower jaw in the genera with but one such tooth, as Ptilodus and Thylacoleo, is the fourth premolar;[2] while the similar tooth in the existing kangaroo-rats, with which it has been compared, is a third premolar. In the living genera the fourth premolar resembles a true molar. It is necessary to remember this fact in the attempt to ascertain the phylogeny of the Multituberculata. This is not an entirely easy task, owing to the questions which arise as to the origin of the cutting premolars themselves. In general it is true of Mammalia that simple premolars precede the complex in time; but an exception to this rule is to be seen in the tritubercular superior sectorial tooth of some Creodonta and Carnivora. Whether the premolars of this family are primitive or derivative is not as yet known. If they be primitive they may be direct modifications of the serrate teeth of the herbivorous Dinosauria or Theromorpha. The complex character of the premolars in the older Tritylodon suggests the possibility of the other alternative. The general history of the Plagiaulacidæ con-

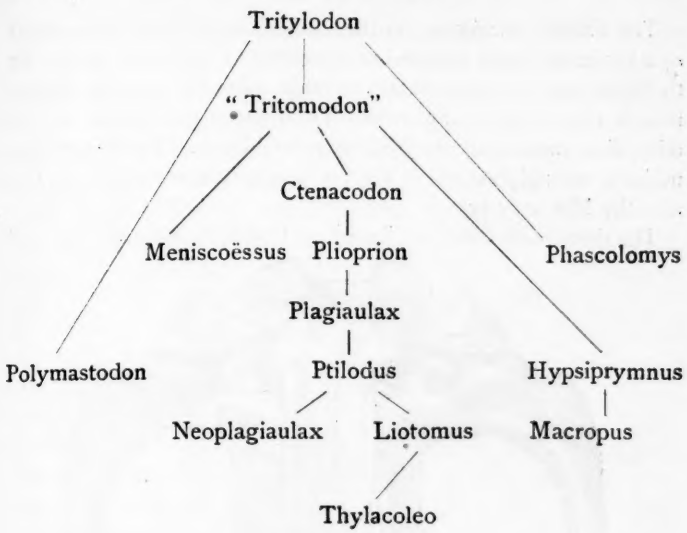
[1] This tooth may possibly belong to a Saurian.
[2] NATURALIST, 1882, p. 521.

firms the theory of derivation from complex premolars, and we observe in the later form, Thylacoleo, a simplification of the true molars also. The molariform fourth premolars in the existing Macropodidæ confirm this view. In order to connect these latter with the ancestral form of the Plagiaulacidæ, on a former occasion, I posited a theoretical form which should combine three of the cutting premolars of the extinct family with the molariform fourth premolar of the Macropodidæ. This I named Tritomodon.[1] The discovery of Tritylodon has added confirmation to this view, at least as regards the prior existence of the molariform premolars. The Polymastodontidæ were probably derived from the Tritylodontidæ by the usual process of reduction of number of teeth and specialization of those that remain. Thylacoleo[2] must be regarded as the type of a family distinct from the Plagiaulacidæ, since it has but one true molar tooth in the upper jaw. The composition of that tooth is unknown, so that it is not certain whether the family Thylacoleontidæ must be placed in the Multituberculata or Sarcophaga. That it is a direct descendant of the Plagiaulacidæ I think there is no doubt. The following phylogenetic scheme is similar to one I published in the NATURALIST, 1882, p. 521, with some addition, and the removal of Polymastodon (Catopsalis) from the Plagiaulacidæ:

FIG. 8. — *Ptilodus mediævus* Cope, left mandibular ramus, nat. size; from the Upper Puerco beds of New Mexico. Fig. *a*, external side; *b*, internal do.; *c*, superior view, $\frac{3}{2}$ nat. size. Original, from Report U. S. Geol. Survey Terrs., III, F. V. Hayden in charge.

[1] NATURALIST, 1882, p. 521.

[2] Owen, Quar. Journ. Geol. Society, London, 1883.



It appears from the preceding considerations that the dentition of the implacental Mammalia has had a history independent of that of the placental series so far as regards the herbivorous types at least. I have shown that the primitive types of the placental series were tritubercular, and then quadritubercular, and then crested. In the herbivorous marsupials, on the contrary, we commence with multitubercular forms, and it is yet an open question whether these have had a quadri- and tritubercular ancestry or not.

The Plagiaulacidæ of the Jurassic period are of very small size, none of them exceeding in dimensions the house mouse. The same is true of the species of the Eocene period hitherto found in Europe. The American species are larger, the *Ptilodus mediævus* equaling probably the Norway rat (Fig. 8), while the *P. trovessartianus* is one-third smaller. The *Meniscoëssus conquistus* is still larger, equaling about the *Polymastodon foliatus* (Fig. 7). The arrangement of the crests of the fourth premolar in the species of Plagiaulacidæ differs as follows: In Plagiaulax, Plioprion and Neoplagiaulax this tooth is grooved. In Ptilodus the grooves have become so wide (Fig. 8) that the wide intervening ribs have become narrow keels. In Meniscoëssus there are no keels, but the margin of the crown is serrate (Fig. 7 *a c*).

The *Ptilodus mediævus* further differs from the *Neoplagiaulax eocænus* in the more rodent-like character of its incisor teeth. In the latter species these teeth resemble more those of the kangaroos in their anterior direction. The diastema is longer in Ptilodus, thus increasing the rodent resemblance. The fourth premolar is strongly serrate in the Neoplagiaulax, resembling in this also the Mesozoic types.

The discussion between Professor Owen on the one side, and

FIG. 9.—*Thylacoleo carnifex* Owen; skull from below, one-half nat. size; from the Pliocene beds of Australia. From restoration by Professor Owen in *Geological Magazine*, 1883, p. 289.

Messrs. Falconer, Krefft and Flower on the other, as to the nature of the food of Thylacoleo, is known to palæontologists. From the form of the teeth alone, Professor Owen inferred the carnivorous nature of the food of this genus, while his opponents inferred a herbivorous diet from the resemblance between the dentition and that of the herbivorous Hypsiprymnus. I have pointed out (*l. c.*) that the comparison of Thylacoleo with Hypsiprimnus

is weakened by two considerations: First, the cutting teeth in the two genera are not homologous; second, the grinding series of molars, complete in Hypsiprymnus, is almost wanting in Thylacoleo. It evidently does not follow that because Hypsiprymnus is herbivorous Thylacoleo is so also. Professor Flower refers to the reduction of the molars in Thylacoleo as slightly complicating the problem, and concludes that the food of that animal may have been fruit or juicy roots, or even meat. It is difficult to imagine what kind of vegetable food could have been appropriated by such a dentition as that of Ptilodus and Thylacoleo. The sharp, thin, serrate or smooth edges are adapted for making cuts and dividing food into pieces. That these pieces were swallowed whole is indicated by the small size and weak structure of the molar teeth, which are not adapted for crushing or grinding anything but very small and soft bodies, It is not necessary to suppose that the dentition was used on the same kind of food in the large and the small species. In *Ptilodus mediævus* the diet may have consisted of small eggs which were picked up by the incisors and cut by the fourth premolars. In *Thylacoleo carnifex* it might have been larger eggs, as those of the crocodiles, or even the weaker living animals. The objection to the supposition that the food consisted of vegetables, is found in the necessity of swallowing the pieces without mastication. In case it should have been of a vegetable character the peculiar premolar teeth would cut off pieces of fruits and other soft parts as suggested by Professor Flower, but that these genera could have been herbivorous in the manner of the existing kangaroos, with their full series of molars in both jaws, is clearly an inadmissible supposition.

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VESTIGES OF GLACIAL MAN IN MINNESOTA.

BY MISS FRANC E. BABBITT.

(Continued from page 605, June number.)

THE notch quartzes hitherto examined have been differentiated by marked peculiarities of distribution, worth while to enumerate in this place.

First: as there were originally no quartzes afforded by the soil above the stratum, so there were none yielded by that lying immediately below; although it would naturally be expected that

the floor of a primitive manufacturing site of this character would be permeated to a considerable depth with chips and other refuse. If in studying the quartz bed, for example, the hand, introduced within it horizontally, was carried at all above or below the superior or inferior plane of deposit, the fingers encountered no more fragments, except in spots where the layer had manifestly been thrown out of place by the growth of roots, and other recent agencies.

The uniform outline of the inferior plane of deposit, taken in connection with the total absence of chips and quartz fragments of every kind, from all explored portions of it, shows that these objects were spread out, primarily, upon a passably level surface of a compact, unyielding nature, such as might have been afforded by a firm sod, or by frozen ground. This peculiar feature of the situation, together with other facts hereafter to be stated, suggests the probability that the quartz deposit is somewhat in the nature of a *cache*, the nucleus of which was an ancient site of manufacture of stone implements. Appearances indicate that shortly after receiving position here, these quartzes were either solidly encased in ice or permanently sealed up in the modified drift at present superimposed upon them. Had it been otherwise, had the containing stratum, prior to its final inhumation, been long subjected to the climatic vicissitudes incident to the actual isothermal line of the region, results would no doubt have followed which, though differing possibly in degree, would certainly have been identical in kind with those now wrought out at the same point. Thus great thaws, soaking and softening rains, and, in short, local floods, however caused, could not have failed to affect exposed quartzes, to have effectually deranged and perhaps altogether broken up the original level of their bed, and to have let numbers of the involved objects down to varying depths in the underlying stone rubbish, while sweeping others away bodily to be distributed about the subjacent sands. It is desirable to emphasize the fact that the specified movements of soil are not merely a matter of speculation, but are the subject of direct observation. They are now in progress before our eyes from day to day, not only at the quartz bed, but likewise at every explored point in the vicinity, at which quartz products of disintegration find lodgment upon a sandy substratum. Let it be observed that the present is not a case of degradation going on upon a basis of

rock affording permanent support to fragments detached. Even were it such, however, the quartzes would still have been subject to eolic influences whence we might look to see the successive products of ages of weathering widely disseminated and occupying different levels in the neighboring sand.

Second: it was a further peculiarity of the quartz layer that it did not thin out toward the west, in the direction of the river, as it should have done had its area been still intact. Contrawise, the quartzes extended in full thickness quite up to the extreme edge of the terrace-plain, where the deposit terminated abruptly in an obscuring layer of surface soil derived from the drift above. Previous to the inception of grading operations upon the notch, by which this ancient cache seems to have been nearly and perhaps quite obliterated, it was no infrequent thing, after heavy rains, to find quartzes, plainly extruded from the others, lying along the bottom-land west of their original bed.

The terrace consists properly of three sections, one above the other, which must have had their beginnings at three different periods. First, we have the lowest and oldest, comprising the body of till and drift below the quartzes; second, the quartz-yielding stratum itself; and third, and newest, the accumulations of modified drift above the latter. This classification is based on existing geological conditions, and formulates the necessary sequence of glacial events. It is, therefore, by no means an abstract or an arbitrary division. It is moreover not affected by the question whether or not the quartz layer is artificial in character. Even were it a proven fact that these fragments are wholly natural forms resulting from the wearing down of quartz veins, it would still be true that the quartzes must, at the time of their deposit, have occupied a surface now no longer existing as such, within the present plane of the middle section. The truncated condition of the western edge of the quartz layer, coinciding with that of the terrace-bank above it, points us back to a time when the two uppermost of these sections had as yet no existence, while the lower one, projected west of its present limits, was prepared to receive upon its surface, as in time it actually did receive, the quartzes now above it. The middle section, that is the stratum of quartzes, must in its turn have had a like westward prolongation. The superior section, deposited later still, participated in the same general extension. When the Mis-

sissippi finally withdrew permanently from the terrace-plain, and cutting out a lower bed for itself in the drift alluvium, formed the existing terrace-bank, it would naturally leave the quartz stratum what we find it to-day. That is, the western border having been cut off and swept away, the western limits of the remainder would preserve a general thickness uniform with that of the central portion, or nearly so.

During a copious and long-continued rainfall in the summer of 1881, the roadway leading through the notch was at one time washed out at its point of emergence and westward to a depth of four or five feet below the quartz stratum. The lower portion of the newly exposed surface was then seen to be stuck full of quartz chips intermingled with occasional quartz implements. These seemed to be vestiges of a former westward prolongation of the quartz-bearing stratum. An irregular block of quartz, from eight to twelve inches in dimension, was here found impacted in the stone rubbish at the top of the till. This is remarkable as being the only lump of quartz larger than a club-head ever encountered among the thousands taken from the place. The block was white, sharply angular, and wholly unwaterworn; it was associated with subangular and rounded stones which had no other visible unwaterworn fragments among them; and it had, still adhering to certain of its planes, foliations of some other mineral of so soft a nature that the blocks would inevitably have yielded to attrition had it ever been subjected thereto. Every appearance indicated that this was a mass which had been used to strike pieces from for further manipulation. It was imbedded among the quartz bits and implements before mentioned. These were strewn about in the utmost confusion, being wedged into the stone rubbish at every imaginable angle. Many of the latter specimens, unlike those from the stratum, were more or less defaced, having small, long bits nicked out of the surface. Among them were some few objects which belonged to stratum types, but which were nevertheless waterworn.

Third: certain of the quartzes of the stratum have been distinctly arranged upon the floor of deposit in little rudely assorted heaps or groups of objects of some one particular type. As a representative fact or two will very likely afford a clearer view of the case than can otherwise be had, a few illustrative details are offered here. During the autumn of 1879, upon the day when

the existence of the quartz-bearing stratum was first definitely settled, I collected from it a half peck, or such a matter, of quartz pieces. Among these appeared a group of specimens numbering a dozen or more, which belonged to a type unknown to me at the time. The most finished implements of this shape have delicate, fragile edges formed by a single thin leaf of the quartz prolonged beyond the mass of the object in a series of irregular, minute notches. Further exploration of the site, continued up to the present time, has, so for as observed, failed to unearth a single specimen of the same class elsewhere. Whether we assume these small articles to be natural productions or artificial ones, or whether again we hold them to be natural forms more or less modified by the hand of man, there is no escaping the conviction that the grouping together of these and other like objects is wholly the work of intention. Previous to the discovery here narrated, I had more than once or twice chanced upon bunches of specimens of a common figure, lying in separate huddles in the sand at the edge of the stratum, and apparently just washed out of it.

Upon another occasion I found in my daily budget a small cluster of rude triangular points, quite unfashioned, as I thought, and averaging about an inch and a fourth, or a half, in length, by three-fourths of an inch in width. These being at first supposed to be unwrought figures, were thrown out as such. However, the persistent recurrence of identical forms in the day's yield eventually suggested a meaning of its own independent of the matter of workmanship. These bits were consequently put in comparison with fragments taken from waterworn quartz boulders from the edge of the Mississippi river, artificially broken up. It was found that certain of these boulders afforded by their fracture occasional specimens of the same general shape with those under study, while upon closer examination it was perceived that a considerable portion of the latter had at the base, upon opposite edges, two very small roundish notches, such as would be required for securing the object to a slender shaft, or handle, of wood or bone. None of the pieces seemed to have been flaked except at these notches, and if they had been otherwise worked at all, they had simply had their natural angles smoothed down by abrasion upon some stone.

Similar assortments of specimens having a common form have

been brought to light in different portions of the stratum. Indeed, whenever I unearthed any individual object of comparatively large size, I very often, though by no means invariably, found it to be associated closely with others of kindred type. I have exhumed from this place groups of axe-like quartzes, of rasping stones, of broken implements, of long prong-shaped objects perhaps utilized by primitive man as weapons, and of other rudely fashioned things at the particular uses of which it is impossible to guess. However, there were also divers quartz shapes which were scattered about through the whole deposit, such as hammer-stones of different descriptions, sharp pieces adaptable as cutting-blades and a great many sharp and long splinters. Some of the latter have been more or less wrought, while others of ruder model appear to have been selected from accumulations of fractured quartz with reference to unknown industries.

The assorted arrangement of the stratum quartzes and the perfect preservation of even the very frailest of them are cognate facts, entirely congruous with the group of statements heretofore advanced. They show that this deposit did not suffer derangement before its final inhumation, nor at the period when the latter was in progress. They point strongly to the probability that these rude objects represent a palæolithic workshop and cache, the floor of which was shielded from disturbance by an icy envelop, or by the gentleness of movement of the encroaching waters, or by both of these causes combined, as is most likely. Were it otherwise possible for the quartz bed to be a product of disintegrating forces, it would still be incomprehensible that a stratum presenting the specific features of this, could have been exposed to the tumultuous action of air and frost during the time requisite for working out the degradation assumed. It is equally unintelligible that it has ever been attacked by the powerful currents of an onward-moving flood. These quartzes seem rather to have been submerged by some such gentle creeping action of water as we should expect in the case of a lake-like expansion produced by the backing up of water from below.

Fourth: the stratum quartzes comprise many distinct varieties of the mineral, distributed among a mass of pieces which have apparently been derived from the quartz-bearing slates of the vicinity. These fragments show strongly marked differences in

opaqueness, color, hardness, cleavage and admixture of foreign matter. The mode of occurrence of the more erratic specimens is noteworthy, and leads to the inference that they may have been fashioned from drift boulders, numbers of them, indeed, having been evidently formed of waterworn pebbles. Objects shaped from some special variety of quartz not unfrequently present themselves in loose clusters, varying in number from two or three to a dozen or so pieces. Thus a single specimen of a tinted, mottled or otherwise distinguishable quality, has quite commonly been found associated with others of the same species of mineral. When one of these is of comparatively large size, the remaining objects are in many cases proportionally small, as if they had been shaped from fragments of the largest. In one part of the stratum I chanced upon several small quartzes which were, for the most part, longish splinters, and which had a peculiar sort of oölitic fracture closely resembling the grain of curly maple. I have never happened to find this sort of fracture in quartz from the Little Falls slates, though such may perhaps exist; but in studying a few boulders from the till, artificially broken up, I discovered a single waterworn mass, ten to twelve inches in diameter, having the same fracture. I afterward, at various times, encountered pieces of similar character at the stratum, three or four perhaps in a spot. These fragments have all, I believe, been inconsiderable in size. Now had even a small lump of this special sort of mineral been either disintegrated, or broken up upon the ground by human agency, a confused mass of bits of different sizes must naturally have resulted—which is not the fact. It is therefore not unlikely that the peculiarity of its cleavage unfitted this quality of quartz for being worked into large implements, but that in accidentally reducing small boulders of it, the quartz-workers selected from the splinters such bits as could in some way be turned to profit.

Professor Winchell says of terrace surfaces adjacent to the quartz stratum: "There is no point throughout the whole region round about where the slate conveying these quartz veins rises to the level of the surface of this plain so as to be within the range of transporting agencies, whether of the water of the river or of floating ice."

This statement concerning fragments diffused through the surface soil is, of course, not necessarily applicable to a plane a con-

siderable depth below that surface. In fact, slate rock has been encountered a little distance east of the notch at a depth of only fourteen feet. It is certain also that exposures of slate veins have long since been eaten away by the Mississippi river on the west, and it is highly probable that all these once afforded the quartz-workers abundant supplies for industrial purposes. A great proportion of the pieces found here have actually been furnished from the quartz-yielding rock of the place. This being the case, however, it is still certain that the imbedded quartzes could not have been drifted to their present position by currents of water, nor by ice. The facts above cited forbid the possibility of such transportation; and, as shown, it is equally incredible that long continued disintegration in the open air should have left upon the fragments successively resulting, no trace of weathering nor of belonging to different planes of deposit. On the whole, the prehistoric record of glacial man at Little Falls, as understood at the present stage of investigation, may be briefly summed up as follows.

The quartz-working people flourished at a day when the upper division of the terrace-plain had not yet been spread out. As we have seen, the basal section of the terrace consists of till coated with stone rubbish and covered with a thin layer of soil. It was precisely here, upon this old surface, that the quartz-workers lived and pursued their pitiful labors. In the fulness of time this vanished folk, perhaps foreseeing the calamity of flood, posed upon the earthen floor adjoining their working-place, the quartz implements of the stratum. The impending disaster finally ensued; the movement of the muddy water inhuming these objects was so gentle as not to break up the original arrangement of assorted groups, nor yet mar the most delicate edges and points of the imbedded pieces. The deposit of quartzes was, at last, hermetically sealed. Except at the western edge it has thus remained, quite in *statu quo*, up to the present time; although there has been a constant tendency on the part of natural agencies to erode the drift above, and expose once more to the light of the sun the rude remains of this primitive race.

The floods at length abated, the waters of the swollen Mississippi wholly subsided; the river abandoned the terrace-plain altogether, it dug out a new bed for itself at a lower level. During the latter process, or subsequent thereto, the current washed out

the western, or river, edge of the quartz deposit, and swept away all such products of man's labor as were at that time exposed to its action. The operating forces having been exerted upon the west of the present terrace-bank, it follows that only the eastern edge of the stratum remains to us, the western border being cut off and lost.

In finale, it is proper to reiterate the fact that the working hypothesis of the moment is one which the writer has been driven, in spite of preconceived notions, to adopt. All the internal evidence of the case, thus far elicited, harmonizes completely with the view enunciated, and with this view alone. The study here commenced is henceforth to be pursued along two distinct lines of investigation; one comprehending the drift surfaces of the region, the other the objects exhumed. The latter, or purely archæological phase of the subject, remains to be more fully developed at some future time; but it may be stated in this place that the quartzes of the cache are to the last degree primitive in their general types and particular forms, and in their style of workmanship.

A collection of something like a hundred of the quartz objects found in the notch at Little Falls has been submitted for examination to Professor Henry W. Haynes, of Boston, Mass., who writes of these specimens: "Some of them I believe to be implements; many are only chips struck off in shaping implements and refuse pieces left from such work; many are natural forms, and one or two rolled pebbles. I think that such objects as appear to be implements, in your collection, were managed by being held in the hand, and that early man had not advanced far enough to devise handles for his first rude implements. The masses of quartz were fitted for use by having most of their projections battered off by another stone; and if anything was required to soften the effect of the edges of stone upon the hand, it was a mass of moss, or leaves, or such object. I trace clearly upon your implements such a preparation of them for holding them in the hand. Many of yours bear evident marks of use in the worn condition of portions of their edges or of their points. When I look over the whole collection that I have made from different localities in New England of rude stone objects, mostly found at some depth below the surface, and compare their general appearance with that of my collection of Indian objects, I

see plainly a great difference. Applying the same test to your quartzes, I see that they belong, as a whole, to the older class. That you have discovered a workshop of early man there is no doubt." Again he says: "I will merely repeat that I have not a shadow of a doubt that the 'quartzes' you have submitted to me are the product of an intentional breaking by the hand of man, and not the result of natural causes."

At the annual meeting of the American Association for the Advancement of Science held at Minneapolis, Minn., August, 1883, a small number of objects from the stratum at the notch, and from its western line of extension along the terrace-bank, were placed for study in the hands of Professor F. W. Putnam, curator of the Peabody Museum of Archæology at Cambridge, Mass. It is with peculiar satisfaction I find myself able to record his decision that a certain part of the quartzes examined by him have indubitably been fashioned by the hand of man. At the same meeting of scientists the following résumé of the glacial situation at Little Falls was contributed to this paper by Mr. Warren Upham, of the State geological survey, to whose personal researches and official reports we are largely indebted for the drift history of Minnesota. The geological data of the present article have, in great part, been drawn from notes kindly supplied for the purpose by Mr. Upham. Mr. Upham says:

"Two principal epochs of glaciation are clearly recognizable, in the earlier of which the ice-sheet extended somewhat beyond the Missouri river and nearly to the Ohio river, crossing the latter at Cincinnati, as recently proved by Professor Wright. All of Minnesota was, at that time, deeply covered by ice, excepting a tract next to the Mississippi river from Lake Pepin southeastward, which is included in a driftless area that extends 150 miles from north to south, and is 100 miles wide, lying mostly in Wisconsin. In the succeeding interglacial epoch there is good evidence that the ice was melted away upon this region, and that a temperate climate existed. Afterward came the second and last great glacial epoch, when an ice-sheet again covered nearly all of Minnesota and accumulated the terminal moraines that have been described in Wisconsin, Minnesota, Iowa and Dakota. The ice in this epoch did not extend so far south as before. Its border in southeastern Minnesota was some fifty miles back from the edge of the driftless area. In Iowa the most southern point that was covered by the ice of this last epoch is in the vicinity of Des Moines, about 300 miles north of its earlier limit. The part of southwestern Minnesota lying beyond the crest of the Coteau

des Prairies escaped this later glaciation. The boundary of this ice-sheet, known by the course of its terminal moraine, entered Minnesota from Wisconsin across St. Croix lake; it crossed the Mississippi ten miles south of St. Paul, and thence extended about fifteen miles westerly to Crystal lake, in Dakota county, where the margin of the ice which moved southwestwardly from Lake Superior and northern Wisconsin met the margin of the ice which moved toward the south and southeast from the region of Lake Winnipeg and the Red River valley; from Crystal lake, the ice-border, at the east limit of the glacial current last mentioned, extended south through Rice, Steele, and Freeborn counties, into Iowa. Two currents of the ice-sheet, one coming from the northeast, the other from the northwest, were confluent, pushing against each other, upon an area reaching from Crystal lake and Lake Minnetonka 150 miles northwesterly to the Leaf hills, and even farther north to the lakes at the head of the Mississippi river. An area, or belt, extending thus, with a width varying from forty to a hundred miles, has a junction and overlapping of the till brought from the northwest and northeast, and series of morainic hills, which appear to prove that this region was wholly covered by the ice of the last glacial epoch; that the line of confluence of its currents was shifted in the latter part of this epoch far to the east upon a large district southeast of Stearns county, bringing till from the west over that from the east; and that during the final melting and disappearance of the ice, probably at times when this was interrupted by its reädvance upon part of the ground from which it had retreated, true terminal moraines were formed upon the sides of this belt which had been wholly ice-covered through most of this epoch. The inner moraine found in southern Minnesota and upon the Coteau des Prairies, the Leaf hills, and the very distinct series of morainic hills in Morrison county—one of which, accumulated by the ice-current from the northeast, lies close east of Little Falls—are of this kind, being terminal moraines formed at stages in the recession of the ice at the last glacial epoch.

"As soon as the ice had so far retreated as to uncover the present valley of the Mississippi river in Morrison county, the deposition of the modified drift, constituting the terrace-plain in which are found the quartz chippings, ensued, and continued during the retreat of the ice.[1] It seems very probable, that vegetation and animals followed close upon the retiring ice-border, and that even man, who lived near the Atlantic coast in this closing stage of the glacial period, as abundantly proved by recent discoveries in the drift-gravel near Trenton, N. J., may also have lived here at that time, and occupied the Mississippi valley directly after the

[1] It is to be borne in mind as an important fact that the Little Falls quartz stratum lies *at the bottom* of the old flood-plain. Hence the quartz-workers must have occupied this spot at the point of time when its deposition began.

ice-sheet retired. While the deposition of the valley-drift at Little Falls was still going forward, men may have lived there, and left, as the remnants of their manufacture of stone implements, the multitude of quartz fragments here described. By the continued deposition of the modified drift, lifting the river upon the surface of its glacial flood-plain, these quartz chips were deeply buried in that formation. The date of this valley-drift must be that of the retreat of the ice of the last glacial epoch, from whose melting were supplied both this sediment and the floods by which it was brought. The glacial flood-plain beneath whose surface the quartz fragments occur, was deposited in the same manner as additions are now made to the surface of the bottom-land; but the flooded condition of the river, by which this is done, was doubtless maintained through all the warm portion of the year, while the ice-sheet was being melted away upon the region of its head waters. In spring, autumn, and winter, or, in exceptional years, through much of the summer, it seems probable that the river was confined to a channel, being of insufficient volume to cover its flood-plain. At such a time this plain seems to have been the site of human habitations and industry, as shown in this paper.[1] After the complete disappearance of the ice from the basin of the Upper Mississippi, the supply of both water and sediment was so diminished that the river, from that time till now, has been occupied more in erosion than in deposition, and has cut its channel far below the level at which it then flowed, excavating and carrying to the Gulf of Mexico a great part of its glacial flood-plain, the remnants of which are seen as high terraces or plains upon each side of the river."

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— The preservation of some herds of our larger game in the parks which are under the direction of the National Government is an object which has received the approval of various prominent persons from time to time. We believe that the constitution of the Yellowstone Park Commission contemplates the preservation of the game within its borders, but does not provide for the maintenance of herds of any size, or for any means of keeping them within the limits of the protected territory. It is asserted, however, that in point of fact the game is not better protected in the Yellowstone park than elsewhere.

[1] Evidence is at present wanting that the quartz-workers revisited this field of operations between the abandonment of the quartz stratum and the spreading out of the uppermost portion of the terrace-plain.

It is well known that the larger game of the far West has been long diminishing in numbers. This is especially true of the bison, an animal which is unable to escape from its pursuers, and which can hardly be called a game animal. The once huge Southern herd has been reduced to a few individuals in Northwestern Texas. The Dakota herd numbers only some 75,000 head, a number which will soon be reduced to zero if the present rate of extermination continues. The Montana herd is now the object of relentless slaughter, and will soon follow the course of the other two herds. When scattered individuals represent these herds, a few hunters will one day pick them off, and the species will be extinct.

Let the Government place a small herd in each of the national parks, and let the number be maintained at a definite figure. Let the excess escape into the surrounding country, so as to preserve the species for the hunters. Let herds of moose, elk, big-horn, black and white-tailed deer, and antelope, be maintained in the same way. Let the Carnivora roam at will; and in a word protect nature from the destructive outlawry of men whose prehistoric instincts are not yet dead. Let the newer instinct of admiration for nature's wonders have scope. Let the desire for knowledge of nature's greatest mystery, life, have some opportunity. Let there be kept a source of supply for zoölogical societies and museums, so that science may ever have material for its investigations. By securing the preservation of these noblest of nature's works, Congress will be but extending the work it has so grandly sustained in the past, in the support of scientific research and the education of the people.

To carry this plan into effect it will be necessary to have an efficient corps of foresters and gamekeepers. Any poaching on the parks must be punished with exemplary severity by the United States courts.

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RECENT LITERATURE.

THE ZOÖLOGICAL RECORD FOR 1882[1].—This volume is sixteen pages longer than its predecessor. The number of new genera and subgenera published in 1882 and recorded in the present volume is 1015, as against 1438 of Vol. XVIII. The editor adds that without the Protozoa, which in the latter comprised 483 from a

[1] *The Zoölogical Record for 1882;* being volume nineteenth of the Record of Zoölogical Literature. Edited by E. C. RYE. London, John Van Voorst, 1883.

single describer (Professor Haeckel), the number is greater by 70 in the present one. "These 1015 are divided as follows: Mammalia, 29; Aves, 19; Reptilia and Batrachia, 34; Pisces, 23; Mollusca and Molluscoida, 67; Crustacea, 46; Arachnida, 64; Myriopoda, 5; Insecta, 598; Vermes, 32; Echinodermata, 30; Cœlenterata, 27; Spongiida, 17; and Protozoa, 24. The unavoidable delay referred to in the preface has necessitated the publication of this long list of new names with scarcely any examination as regards prior occupation."

A number of changes have taken place in the staff of assistant editors, but we do not see that the quality of the reports has been lessened in value.

As regards Mammalia, the year 1882 did not differ materially from its predecessor in the large number of papers, anatomical, systematic and faunal, which appeared, though but few separate works of importance were published.

Of the ornithological publications of the year, special attention is called by the assistant editor, Mr. Sharpe, to the completion of Elliott's "Monograph of the Hornbills," Sclater's "Jacamars and Puff-birds," Salvadori's "Uccelli di Papuasia," and the atlas to the part "Aves" of the great work on the natural history of Madagascar, by MM. Milne-Edwards and Grandidier. Attention is also called to the valuable essays by Drs. Gadow and Krukenberg on the coloring of feathers. As usual the reports on insects fill nearly half the volume, *i. e.*, 292 pages.

As regards the value of this work to working naturalists, in this country especially, where few have access to large libraries, we can only repeat the statements heretofore made as to the usefulness of such a record as this. The report is subsidized, and, as a matter of course, endorsed by the British Association for the advancement of Science, as well as the Royal Society of London.

COLLINS'S MINERALOGY[1].—The system of classification adopted by the author is identical with that of Dana so far as the primary classes are concerned. The book is reprinted from the English edition, and like the first volume, published in 1878, was prepared for the use of "practical working miners, quarrymen and field geologists," as well as "students of the science classes in connection with the Department of Science and Art." The work, as the author says, is little more than a dictionary of minerals, which includes notices of all described up to the beginning of 1881.

The criticism we would make on this little unpretentious book, is that the class for which it is intended need full descriptions of the more common minerals and ores, their mode of occurrence and relations to one another, rather than a simple list with too brief descriptions of or reference to all that are known.

[1] *Putnam's Advanced Science Series. Mineralogy.* By J. H. COLLINS. Vol. II. Systematic and descriptive Mineralogy, with upwards of 400 illustrations. [1884.] 12mo., pp. 328.

We still need a brief class-book of mineralogy for college students and beginners, one which shall lead the student to carefully examine at least the physical characters of not over, say a hundred, of our rock-making and other more important minerals, such as are constantly met with by amateurs, miners and prospectors. Such a book should also enter fully into the methods of study for the examination of minerals by their physical characters, comprising a set of object-lessons which may be made of much value and interest to college and other classes.

THIRD REPORT OF THE U. S. ENTOMOLOGICAL COMMISSION.—This report forms a volume of 550 pages, with an appendix of nearly 100 pages, and is illustrated by sixty-four plates. It is divided into three parts. Part I, in reference to the Rocky Mountain locust, has five chapters. Chapter 1 comprises additions to the chronology of locust ravages in 1880 and 1881. Chapters 2, 3 and 4, by Mr. Lawrence Bruner, contain his reports and notes on the locust and cricket (Anabrus), giving the results of the expeditions made by him under direction of the Commission, into Northern Montana and British America, Chapter 5 is an essay on "the data obtained from solar physics and earthquake commotions applied to elucidate locust multiplication and migration," by A. H. Swinton, of England, communicated by him and published by the Commission without its endorsing all the author's views.

Part II comprises chapters 6–8, the 6th on the army worm; the 7th on the canker worm, each by C. V. Riley, and the 8th on the Hessian fly, by A. S. Packard, Jr., being a reprint, with additions and other changes, of Bulletin 4 of the Commission. Part III, Scientific results, comprise four chapters, each by A. S. Packard, Jr.; the 9th containing descriptions of certain larvæ of injurious forest insects, illustrated with numerous drawings by Dr. C. F. Gissler, and filling ten plates. Chapter 10 discusses in a fragmentary way certain points in the embryology of the *Caloptenus spretus* and *C. atlanis;* it contains some speculations as to the origin of the wings, and the genealogy of the insects. It closes with a brief account of some points in the development of the bark-boring beetle *Hylurgops pinifex* and *Xyleborus coelatus*, with remarks on the number of segments in the head of winged insects.

Chapter 11 is devoted to an essay on the systematic position of the Orthoptera in relation to other orders of insects, portions of which have appeared in the NATURALIST. This chapter is illustrated with forty-two plates, giving in a comparative way the leading points in the external anatomy of the Orthoptera, Dermatoptera, Pseudoneuroptera and Neuroptera.

Chapter 12 is a note of two pages explaining a zoö-geographical map of North America, with remarks on the distribution of locusts.

THE COAL AND IRON COUNTIES OF NORTH CAROLINA.—The mineral resources of North Carolina have been exposed by the recent survey of that State by Professor Kerr, and the present hand-book, which follows the foregoing, has been compiled by P. M. Hale, mainly from the reports of Emmons and of Kerr, for the purpose of calling the attention of the people of the State, as well as immigrants, to the mineral wealth of this naturally rich State. After describing the coal fields and iron ore beds in general, the coal and iron counties are separately described, the statistics being derived from the census reports of 1880. It is accompanied by a colored map of the State.

ZITTEL'S HAND-BOOK OF PALEONTOLOGY.—The third part of the second volume of this important work is devoted to the Cordaiteæ, but more especially to the Coniferæ; and the mode of treatment as well as the excellent illustrations will make it of great value to the investigator and student as well as the teacher. Here we have represented forms of the Gingko and allied genera of broad-leaved conifers which will be quite new to most of our readers; the same may be said of the fossil Araucariæ, as well as the Taxodineæ, nearly every genus of which is illustrated; so also of the Cypressineæ.

BREHM'S THIERLEBEN.—We have received the chromo-plates of ten mammalian subjects (Mappe 5)—and very beautiful and soft they are—of this magnificent work. It will be remembered that an edition of this work with a set of 170 chromo-lithographs is in course of publication. Those who possess the original work can obtain the colored plates separate of B. Westerman & Co., New York City.

RECENT BOOKS AND PAMPHLETS.

Lydekker, R.—Memoirs of the Geological Survey of India. Palæontologia Indica, Ser. X, Vol. II. Part IV. Siwalik Camelopardalidæ. Part VI. Siwalik and Narbada Carnivora. Calcutta, 1884. From the author.

Russell, I. C.—Sketch of the geological history of Lake Lahontan, a Quaternary lake of Northwestern Nevada. Washington, 1883. From the author.

Meek, Seth E., and Newland, R. G.—A review of the American species of the genus Sphyræna. Ext. Proceedings Nat. Sci. Phil., 1884. From the authors.

——Notes on a collection of Anchovies from Havana and Key West, with an account of a new species (*Stolephorus eurystole*) from Wood's Holl, Mass. Ext. idem., 1884. From the authors.

Jordan, D. S.—Notes on species of fishes improperly ascribed to the fauna of North America. Ext. Proceedings Nat. Sci. Phil., 1884. From the author.

——List of fishes from Egmont Key, Fla., in the museum of Yale College, with description of two new species. Ext. idem., 1884. From the author.

Owen, R.—On the skull and dentition of a Triassic mammal (*Tritylodon longævus*) from South Africa. Ext. Quart. Jour. Geol. Soc., Feb., 1884. From the author.

Socy. of Naturalists, E. U. S.—Records of the Society of Naturalists, E. U. S., Vol. I, Part I, 1884. From the society.

Geol. Society.—List of the Geological Society of London, Nov. 1, 1883. From the society.

Chapman H. C.—History of the discovery of the circulation of the blood. Phila., 1884. From the author.

Sims, Wm.—Kansas; its resources and capabilities, its position, dimensions and topography. Prepared by the State Board of Agriculture. Topeka, Kansas, 1883. From the author.

Brendel, Fredk.—Flora Peoriana. Die Vegetation im Clima von Mittel-Illinois. Ext. Termeszetrajzi Fuzelek, Vol. v, 1882. Budapest. From the author.

Mercer, S. W.—A new photo-micrographic camera. In "Photography," Chicago, May 1, 1884. From the author.

Greene, C. A.—An essay on insects injurious to vegetation.

Ryder, J. A.—A contribution to the embryology of osseous fishes, with special reference to the development of the cod (*Gadus morhua*). Washington, 1884. From the author.

Zoöl. Soc. London.—Report of the council of the Zoölogical Society of London for 1883. London, 1884. From the society.

Penna. State College.—Circular of the Pennsylvania State College of Agriculture, 1883.

——Agricultural Bulletins. No. v. Experiment on timothy and clover. No. vi. Feeding experiments. No. vii. An experiment with native potatoes.

Dawkins, Boyd.—The Channel tunnel. 1882. From the author.

Stefanescu, Gr.—Anuarulu Biuroului Geologicu. Anulu 1882–1883. Bucuresci, 1883. From the author.

Dabney, Ch. W.—Agricultural experiment station, N. C. Analyses and valuations of fertilizers. Made up to May 1st, 1884. From the author.

——North Carolina Phosphates. 1884. From the author.

Stevenson, W. G.—The physiological significance of vital force. From the author.

Frazer, Persifor.—Reply to a paper entitled "Notes on the Geology of Chester valley and vicinity." Ext. Jour. Franklin Inst., April, 1884. From the author.

Brinton D. G.—Aboriginal American authors. Phila., 1883. From the author.

White, J. W.—The prevention of syphilis. Rep. Phila. Medical Times, Jan. 14, 1882. From the author.

Rollins, J. S.—The forty-second Missouri University catalogue, 1883–1884.

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GENERAL NOTES.

GEOGRAPHY AND TRAVELS.[1]

AFRICA.—Letters from Lupton Bey, dated down to November 10th, give much geographical information, and a map of the region traveled over by Mr. Lupton or his agents, as far as the Khuta, a large stream which is thought to be a tributary of the Congo.

M. Mizon has written to the Geographical Society of Paris an account of his travels in the region of the Ogowe, its tributary the Liboumbi; the Luété, a tributary of the Niari; the lakes of Mayumba, and the basin of the Kuilu.

Ogadine is the name of a central district occupied by Somali tribes. On the west it borders on the Galla tribe of the Eunyas. The general aspect of the country is that of a steppe covered with long grass, but with stony gaps. The shepherd inhabitants are fanatical Mussulmans, always at war among themselves or

[1] This department is edited by W. N. LOCKINGTON, Philadelphia.

with their neighbors. Toward the Webbe the people are more agricultural. Each encampment has its iman, and every tribe its extempore poets.

Don Juan de Sosten (Bol. de la Soc. Geog. de Madrid) gives an account of his expedition in Eastern Africa. From Adowa (Tigre) he ascended the mountain Deyam, reputed the highest of the mountain range of that part, and found it to be 4631 meters in height. It was evident, however, that another peak, that of Bajuit, was higher; this was also ascended by Sr. Sosten, who found it to be 4917 meters in height, and capped with snow. Sr. Sosten afterwards explored the labyrinth of forest-covered mountains known as the district of Zebul (12° 12′ to 12° 47′ N. lat., 40° 25′ E. lon.). This is united on the south by a range of hills to the Ethiopian table-lands, from which it is distinct in its geology and its flora. Our traveler then crossed the Galla country to the west of Zebul, and proceeded southward, crossing several streams which pour from the eastern slope of the Ethiopian chain. Two of these, the names of which are written by him Mersé and Addifuha (Adifuya?), are not to be found in any map, nor have they been explored. Lake Haic (11° 23′ N. lat., 40° 5′ E. lon.) is 1920 meters above the Red sea, is surrounded by mountains from 2000 to 2500 meters in height, and covers some sixteen square miles. The principal stream flowing into this lake comes from the south and was tracked by our traveler to a previously unknown lake called Ardibbo, 2088 meters above the sea. This lake is somewhat smaller than Lake Haic. The water discharged by Lake Ardibbo into Lake Haic is twenty-nine times greater than that which it receives from streams, and it is an unexplained problem whence the water comes. From Lake Ardibbo our traveler proceeded eastward till he reached the Melle near the junction of the Addifuha. The Melle was then followed to its confluence with the Hauasch, which was seen to slope towards a large lake, probably Lake Ausa. At this point the bold traveler's intention to explore a route to the Red sea was frustrated by the appearance upon the hills of armed bodies of Gallas, of a tribe known to mutilate alive prisoners taken in war. To escape these, the Hauasch was crossed by night, a forced journey made to the south, and then a rapid retreat westward. Farther explorations were now stopped by a command from King John to appear before him to answer the accusations of an enemy, who asserted that Sr. Sosten was a spy of the Egyptian government. On the return journey the tombs of Cristobal de Gama and his companions, who in the fifteenth century fell in the service of the King of Abyssinia, were discovered.

The Pacific Islands.—*Krakatau.*—The late eruption has dismembered the Island of Krakatau. Part of it forms Steers island, eight miles to the north, while another part constitutes Calmeyer island, seven miles north-east, blocking the

east passage of the Straits of Sunda. Only the southern part of Krakatau remains, and there is nearly 170 fathoms of water where the remainder once stood. Lang island remains almost unaltered, but Verlaten island is largely increased. These two islands are believed by Mr. Norman Lockyer to be raised portions of the edge of a vast subsided crater, while the vanished part of Krakatau consisted of cones erupted upon the old crater floor, which has thus been cleared by the explosion. Vertical vibrations were noted at Batavia on May 20th, and ashes fell at Telok-betong and Semangka, in Sumatra. The movements seemed to come from the west, but Krakatau was quiet, and nothing was noted at Anjer, twenty-seven miles from Krakatau. On the evening of the 21st smoke was observed to issue from that peak, which thenceforward continued active, but as no great disturbance occurred, its eruption was scarcely noted at Batavia, eighty miles distant. In a letter to *Nature*, Mr. H. O. Forbes records the passage, on July 11th and 12th, of the vessel he was in through extensive fields of pumice, the nodules of which were worn, and in some cases bore barnacles of four or five weeks growth. On August 1st the steamer *Siam* sailed for four hours through a pumice sheet 700 miles from Sumatra, at a spot where there was 2000 fathoms of water. The current was running eastward, while the locality was some sixteen degrees west of Krakatau. As it seems impossible that this pumice came from that volcano, it is supposed that its final explosion was probably preceded by a submarine outburst in the Indian ocean.

On August 21st Krakatau increased in activity, and on the 26th violent explosions took place, accompanied by high waves which caused much damage. A night of pitchy darkness, and terrifying electric phenomena followed this. Between five and seven o'clock on the morning of the 27th came the first grand explosion. The column of smoke and ashes could be seen from Batavia, and the whole western end of Java and the south of Sumatra for hundreds of square miles was covered with the débris.

Between ten and twelve in the forenoon of the same day the last supreme outburst occurred, and spread consternation across a diameter of 3000 miles. The great tidal waves were registered by the tide-gauges four times round the globe; and from that day to the present time unusual phenomena have taken place that are probably referable to this grand explosion.

Mr. Chalmers has recently returned from a voyage along the coast of New Guinea. He has discovered a new river, which he has named the Wykeham, and believes that this and a number of other river mouths near it form the delta of a great river which probably drains the north side of the great mountain range of New Guinea. It is thought at Port Moresby that probably

D'Albertis in his voyage up the Fly river missed the main body of water.

J. Peltzer writes from Tucson, Arizona, to the Société Royal Belge de Géographie, to prove that the Polynesians are not a Malay, but a pre-Malay race. This race he believes to be identical with the Dyaks of Borneo, and to have spread from that island over Sumatra, Java, and other East Indian islands, previous to the arrival of the Malays. Everywhere where they colonized they displaced the Papuan races, but when the Malays came as a conquering race from the coasts of Hindostan, towards the first century of our era, this people of Dyak origin was partly pressed in to the interior of the large islands, but partly emigrated eastward in their prahus, colonizing the islands of Oceanica. The Malays, once Brahminists, are now Mussulmans, and everywhere repudiate any relationship with the peoples of the interior, the "Orangs Benua" or "men of the land" of Sumatra, the "Orangs Gœnong" or "men of the mountains" of Java, or the Dyaks of Borneo.

M. Peltzer asserts that the Polynesian languages do not contain more than thirty words of Malay origin, a number which may easily be accounted for by the relations between the Dyaks and the Malays who conquered the coast of Borneo. There are great resemblances between the traditions and religious customs of the Dyaks and of the Polynesians. The Tabu of the latter is identical with the Pamali of the former. Among both peoples woman has an inferior position, yet may become chief or queen of a tribe. Both peoples build large dwellings used in common. The Tahitians and people of the Marquesas expose their dead on platforms, and the Dyaks expose the bodies of their chiefs in a similar way.

GEOGRAPHICAL NOTES.——Major Holdich has succeeded in ascending Takht-i-Suliman, overlooking the Indus valley, and has triangulated over 50,000 square miles from its summit.——The furthest point inland reached by Lieut. Armil, though 120 miles from Port Moresby, was probably not more than forty from the southern coast. The natives were found to be very friendly. The country was mountainous and difficult, but exceedingly fertile and beautiful.——Mr. H. Drummond reports that the soil south of Lake Shirwa is thin and poor, and the district quite uninhabited. It is evidently the dried-up bed of a much larger Shirwa. The height of the lake was found to be lower by nearly 200 feet than it is given on Ravenstein's map, where it is marked 2000 feet. The natives say that the Lujenda does not flow out of Lake Shirwa, but is separated from it by a large sandbank.——Capt. Sörensen reports land north-east of Spitzbergen, about 110 English miles from Rep island. This is probably the same as that seen by Capt. Kjeldsen in 1876, and named White island.

GEOLOGY AND PALÆONTOLOGY.

LYDEKKER ON EXTINCT MAMMALIA OF INDIA.[1]—The noble volume below named, concludes the first part of the work of Dr. Lydekker on the Fossil Mammalia of India. It covers a part of the subject which was left very incomplete by Cautley and Falconer, and includes much new matter. It adds materially to our knowledge of the Mustelidæ, Ursidæ, Canidæ, Viverridæ, Felidæ, and Hyænidæ. Dr. Lydekker shows that India, in the late Miocene period, was the headquarters of the genus Hyæna, there being no less than five species represented in the collection. Of Ursidæ there are five species, viz., two of Ursus and three of Hyænarctus, of which one Ursus and two Hyænarcti are new. The latter genus receives thorough treatment, and Dr. Lydekker has added greatly to our knowledge of its characters. There are four species of Canidæ and nine of Felidæ. Of the latter, two species are sabre tooths. Two species of Mellivora and one of Mellivorodon (gen. nov.) represent the Mustelidæ.

The descriptions of the species are thorough, and the plates are excellent. Dr. Lydekker exercises a healthy conservatism in the matter of species, and a rather greater degree of the same trait in dealing with genera. He is disposed to drop generic divisions whose characters are not of the highest degree of importance. To this course we object, that if we begin to neglect anatomical characters, we end in a disuse of all genera, or in purely arbitrary divisions. The only reason for not regarding an anatomical character as a generic definition, is the inconstancy of that character in the different individuals of the same species. The result of not using such an obvious character as the presence of an additional digit on the fore foot, is seen in the author's treatment of the genus Aceratherium. Having failed to recognize as genera the steps which separate this genus from Rhinoceros, he is now fain to confess that the existence of the intermediate forms "probably indicates that there is really no distinction between Aceratherium (in the sense in which it is used here) and Rhinocerus; although the retention of the former is convenient." We maintain that the same logic will require the union of Orthocynodon and Amynodon to this series, and ultimately of Hyrachyus, the ancestor of the line. We have long been of the opinion that there is no course open to the systematist, other than the recognition of the structural steps by which the stages of the genealogical lines are marked. (See "Origin of Genera," 1868.)

The doctor justly says that the name *Ursus ursinus* is ridiculous. We wish those who write *Mephitis mephitica*, *Sialia sialis*, etc., could take a similar view. The adoption of generic names

[1] Series X, Vol. II, of Memoirs of the Geological Survey of India; Siwalik and Narbada Carnivora. Vol. II. Siwalik Camelopardalidæ, 1883. Vol. III. Additional Perissodactyla and Proboscidia.

which have been published without definitions finds little favor in this work. It is because the names of Bravard are mostly *nomina nuda*, that they are either neglected or ascribed to the author who took them up and clothed them, which was sometimes kindly done by Professor Gervais. The suspicion of cross affinities between hoofed animals and Carnivora is evidently entertained by Dr. Lydekker (p. 239). He says, "It has lately been shown that there are some remarkable indications of affinity existing between certain extinct suina (Achænodon) and the bear-like Carnivora." We hold that such supposed affinity is impossible, and that the only way of tracing the connection between the Artiodactyla and Carnivora is by the way of the Amblypoda and Taxeopoda on the Ungulate side, and of the Creodonta on the Unguiculate side. The real position of Achænodon yet remains to be ascertained.

A supposed species of Hyænodon is described from the Siwaliks. We venture the prediction that the animal (which is only known from an inferior premolar tooth), will turn out to be a member of a different genus and family, and to belong to the true Carnivora. The existence of an upper Miocene Hyænodon must be doubted until fully demonstrated.

Some important additions to this work appear in the appendix as a result of the receipt of the latest publications.

In the memoir on the Camelopardalidæ Dr. Lydekker describes seven species from the Upper Tertiaries of India. These belong to six genera; Camelopardalis, Vishnutherium Lydd., Helladotherium Gaud., Hydaspitherium Lydd., Bramatherium Falc., and Sivatherium Caut. and Falc. Hydaspitherium only, possesses two species from Indian beds. The *Camelopardalis sivalensis* was about the size of the *C. giraffa*, and of similar proportions. Dr. Lydekker follows the authorities in placing the family next to the Cervidæ. Probably the genus Cosoryx is the American and primitive representative of the family. In a foot-note quoting Murie, it is stated that Professor Cope believed that the genus Megacerops is allied to the Sivatherium. This is an error, for it was Leidy who expressed that opinion at the reference quoted. Cope referred it to the group to which it belongs, the Perissodactyla.—*E. D. Cope.*

Geological Notes.—*General.*—R. B. Foote (Mem. Geol. Surv. India) in his notes on the geology of the Madura and Tinnevelly districts, recognizes the following strata, commencing at the surface: 8. Soils and sub-ærial deposits; 7. Blown sands, red (teris), white (coast dunes); 9. Fluviatile and marine alluvia, Kaukas deposits; 5. Sub-recent marine beds, limestones and grits, upraised coral reefs; 4. Lateritic conglomerates, gravels and sands; 3. Gritty sandstones; 2. Gondwana rocks (Jurassic ?); 1. Gneissic rocks. The great hills of red sand in Southeast Tinnevelly

form three or four small fresh-water lakes by damming back the drainage.

In another of the memoirs of the same survey, W. T. Blanford describes the hills on the Sind and Punjab frontier. The recognized strata in Sind are the Siwalik (Pliocene and Upper Miocene), the Gaj (Miocene), the Nari, Upper and Lower (Lower Miocene? Oligocene), the Khirthar (Eocene), the Ranikot (Lower Eocene), the Deccan trap (Transition or Laramie) and limestone with hippurites, probably cretaceous. Two Melanias, a Paludina, and four Unios are described.

Palæozoic.—The first part of the fifth volume of the Palæontology of the Geological survey of New York is devoted to the Lamellibranchiata Monomyaria. The new species described are *Aviculopecten æquilateralis;* six species of Pterinopecten; *Pterinea grandis* and *interstrialis*, *Vertumnia reproba;* eight species of Actinopteria; fourteen forms of Ptychopteria; six species of Leioptera; thirty species of Leptodesma, and three of Mytilarca. All are from the Upper Helderberg, Hamilton or Chemung groups.——S. A. Miller (Jour. Cin. Soc. Nat. Hist.) describes *Palæaster magnificus*, from the Lower Silurian of the Hudson River group, and *Gomphoceras faberi* and *cincinnatiense* from the same group.——U. P. James (loc. cit.), describes a Stromatopora, a Fistulipora and a Cerampora, from the Cincinnati group.——E. O. Ulrich (Jour. Cin. Soc. Nat. Hist.), describes thirteen species of Polyzoa belonging to the genera Rhombopora, Cystodictya, Fistulipora, etc.——Professor P. M. Duncan (Quart. Jour. Geol. Soc.), describes *Streptelasma rœmeri*, a new coral from the Wenlock shale, also *Cyathophyllum fletcheri*, from the same formation.——The report of Messrs. R. Etheridge, H. Woodward and R. Jones on the fossil Phyllopoda of the Palæozoic rocks, enumerates thirty-three genera, with a short diagnosis of each, and gives a full description of Hymenocaris, Caryocaris and Lingulocaris.——Mr. J. F. Whiteaves (Trans. Roy. Soc. Canada) describes and figures some supposed annelid tracks (Gyrichnites), from the Gaspé sandstones.

Silurian.—Ch. Barrois (Ann. Soc. Geol. du Nord 1883), gives notes on the Silurian fauna of Haute-Garonne.

Mesozoic.—M. E. Sauvage (Annales des Sciences Geologiques), describes the fossil reptiles of a bone bed in the Rhetian of the department of Saone-et-Loire. The beds contain also numerous mollusks. The species described are *Rachitrema pellati; Aetiosaurus gaudryi; Ichthyosaurus rheticus* and *carinatus*, and *Plesiosaurus bilraetensis* and *costatus*, all, save the last, new species. The character of the fauna is intermediate between that of the Lias and Trias and the flora is of the same mixed character.——J. S. Gardner (Quart. Jour. Geol. Soc.), contributes a monograph on the British Cretaceous Nuculidæ.——The report of the Geological and Natural History Survey of Canada has a description by J. F.

Whiteaves of the fossils of the coal-bearing Cretaceous deposits of the Queen Charlotte islands. From the upper shales the only species described is *Inoceramus problematicus.* From the coarse conglomerate below the guard of a belemnite is the only fossil yet obtained, but from the lower shales and sandstones nineteen Cephalopoda and seven Gasteropoda, besides Lamellibranchs, are known. The majority of the species are new.——In the Transactions of the Royal Society of Canada, Mr. Whiteaves describes some fossils from the Lower Cretaceous rocks of British Columbia. Though the equivalents of the Upper Cretaceous of Europe have been recognized over a vast extent of country in North America, the Lower Cretaceous, with the possible exceptions of the Dakota group and the Shasta group, has only been recognized during the last seven years by the researches of Dr. Dawson in British Columbia. It is now believed that the equivalents of each of the sub-divisions of the Middle Cretaceous, as well as of the "Neocomien superieur," Lower Greensand, or upper sub-division of the Lower Cretaceous have now been found there. From this formation Mr. Whiteaves enumerates thirteen species of mollusks, three of which he describes as new.

Jurassic.—J. Wohlgemuth (Soc. des Sciences de Nancy), publishes the results of his researches among the middle Jarassic strata to the east of the Paris basin, including the Bathonian, Callorian, Oxfordian, Corallian and Astartian strata. Both upper and lower Oxfordian are recognized.

Cretaceous.—Professor P. M. Duncan (*Geol. Mag.*, Jan.) clears up the ambiguity that has rested upon *Galerites albogalerus* Lam., which, with Loven, he regards as synonymous with *Echinoconus conicus* Breynius. The species is not a toothed echinid, as it has usually been regarded; it has no auricles; the anus is not entirely infra-marginal; and there is no fifth genital plate in the apical system.

Laramie.—M. Neumayr (Neu. Jahrb. fur Min. Geol. und Pal., Stuttgart 1884) notes the parallel position occupied by the Laramie group in Northwest America and the Inter-trappean beds of the Deccan in Hindostan. Both are placed between the Cretaceous and the Eocene, and the resemblance of the fossil fauna is well brought out in the subjoined lists:

NAGPOOR.	LARAMIE.
Physa prinsepi	*Ph. copei*
" " var. *elongata*	*Ph. disjuncta*
Acella attenuata	*Ac. haldemanni*
Paludina virapai	*Hydrob. anthonyi*
Unio carteri	*Unio gonionotus*
Corbicula ingens.	*Corb. cleburni*

Tertiary.—The Palæontological Hand-book of Dames and Kayser, 1883, contains a description of the fossil mammalia of Punin

Ecuador, with a geological treatise by W. Reiss. The species noted are Mylodon (sp), *Equus andium*, *Protauchenia reissii*, new genus and species; Cervus, sp., *Cervus chilensis*, *Mastodon andium* and *Machærodus neogæus*. The authors believe in the total extinction of the horse in America and its reintroduction by the Spaniards.——M. P. J. Van Beneden (Ext. des Bull. de l'Acad. Roy. Belg), describes some bones of a Sphargis found in brick-earth of the upper Oligocene period. He names the species *S. rupeliensis*. Fossil remains of the leathery turtle have to a great extent escaped palæontologists, and these bony dermal plates have been described as belonging to Ostracion, and have even been associated with Zeuglodon and with Armadillos. Four species of fossil Sphargis are not known, the others being *S. pseudostracion*, *S. psephophorus*, and the Alabama species that was associated with Zeuglodon.——The last number of the Quarterly Journal of the Geological Society contains notes on Brocchi's collection of Subappenine shells, by J. G. Jeffreys. Brocchi Conchologia fossile Subappenina was published in 1814, and was a remarkable work for a time when palæontology was in its infancy. Many of the errors are here eliminated. Mr. Jeffreys concludes that the deposits in which these shells occur were laid down in seas not exceeding fifty fathoms in depth, and states that not the slightest difference can be detected between any of the fossil species in the Pliocene formation which still survive, and their descendants of the present day.

BOTANY.[1]

Notes on Fungi (*Continued from the May number*).—The different species of Polyporus vary much in size. The specimen of *Polyporus berkeleyi* Fr., from which the specimens in North American Fungi were taken, was two feet across and weighed fourteen pounds, while *P. cupulæformis* B. & Rav., is only from one-eighth to one-quarter of an inch in diameter, with pores so fine as to be hardly visible without a lens. The external surface is also very variable. In *P. lucidus* the pileus is of a chestnut red color and smooth as if varnished, while in *P.* (Trametes) *hydnoides*, a subtropical species, the surface of the pileus is thickly clothed with a coat of black stiff bristle-like hairs. A very curious and unusual form of Polyporus is seen in *P. pendulus* B. & C., which grows on the under side or in cavities inside of rotten logs of oak and pine. The pileus is obconic in shape, ¼–½ an inch across, and is *suspended* by a slender stem about half an inch long. When mature it bears a striking resemblance to the basal portion of a tufted specimen of *Hemiarcyria rubiformis* from which the capillitium and spores have disappeared, and being of a similar color to this little Myxogaster it is, at a casual glance, easily mistaken for it. It also bears some resemblance to a small nest of the red

[1] Edited by Prof. C. E. Bessey, Ames, Iowa.

wasp hanging from the under side of a dead limb or stick, though the color is different. Still more remarkable is the species found on spruce trees (*P. volvatus* Pk.) in New York, and afterwards on *Pinus contortus* in California by Dr. Harkness. In this species the projecting margin of the pileus is incurved so as almost to enclose the pores, leaving only a small opening, ⅛–¼ of an inch across. Very similar to this, but probably specifically distinct, is a Polyporus collected in Oregon by W. C. Carpenter, a correspondent of Isaac C. Martindale, of Camden, N. J. In the specimen seen the pores are entirely inclosed and occupy the upper surface of the cavity. The specimen appears to have grown on the upper surface of a fallen tree or perhaps on a horizontal branch. It is oblong in shape, about one and a-half inches long by one inch high and broad, and is of a yellowish color. It appears to differ from *P. volvatus* in its rather larger pores with acute white mouths. The area occupied by the pores also is not so definitely limited, the length of the pores gradually decreasing from the center till the marginal ones are mere points without any appreciable depth. This has been named provisionally *Polyporus inflatus* Ell. & Martindale, but additional specimens and information will be requisite to describe more fully all its characteristic features.—*J. B. Ellis, Newfield, N. J.*

Structure and Physiology of the Passion Flower (*Passiflora lutea*).—The passion flower of Ohio is greenish-yellow, about two centimeters broad, having a crown tinged with purple. From the center of the crown, surrounded at its base by the honey gland, rises the column of stamens, united into a sheath which above again separates into five filaments bearing the anthers. Included by this column of stamens is a stalk which bears the ovary. There are three styles. In case the flower does not set seed it falls off at a joint a short distance below the flower (Fig. 4). In

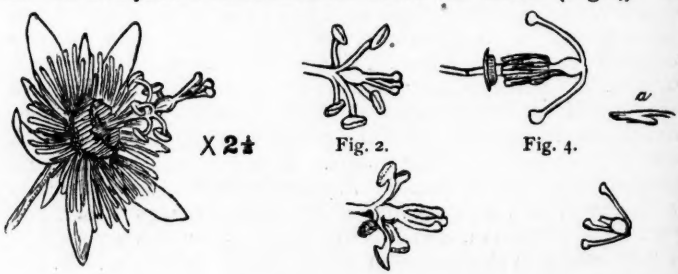

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 1.—*Passiflora lutea*, flower in male state. Fig. 2.—Stamens (and styles) just before maturity. Fig. 3.—Stamens at maturity. Fig. 4.—Female state of flower, stamens and styles only represented, *a*, one of the stamens. Fig. 5.—The pistil.

plants grown in my room, none of which were accessible to in-

sects, all the flowers fell off, but in the woods this was not the case. Since my plants were perfectly healthy, I concluded that this flower requires insect agency, and is sterile in case it does not receive it. The structure of the flower also leads to this conclusion.

In the bud both stamens and styles have an upright position, the anthers being intorse (Fig. 2)! The stamens begin to spread out, take a horizontal position and soon begin to recurve. The anthers at the same time become first vertical, *i. e.*, at right angles to the filaments at that time. Then they bend a little further on the filaments, and when these have recurved they appear somewhat as if they had been extorse in the beginning (Figs. 3 and 1). In this condition they are prepared to leave pollen on the backs of visiting insects as they take the honey from the cup-shaped gland surrounding the base of the column of stamens. Then the stamens, having fulfilled their mission, move slowly onward until the anthers are pressed against the column, in which shape they look decidedly as if they had at first been extorse (Fig. 4 *a*). In this shape they are effete, since the pollen must fall on the back of the insect to fertilize the plant. The styles have by this time separated and recurved, and taken the place which the stamens formerly occupied (Fig 4). The styles, however, keep a rather straight appearance when they have once the desired position as represented in Fig. 5. This then is the female state of the flower, and if the stigmas do not receive pollen the flower falls off. This is then a distinct case of proterandry, showing correlative motions in styles, filaments and in the anthers at their place of attachment. I have not found insects upon the flower, but the extreme rarity of the plant in this locality is a sufficient reason. The statements above are enough to show that there must be such visitors. The stigmas never touch the anthers in this species.—*Aug. F. Foerste, Granville, Ohio.*

Conspectus generum Discomycetum hucusque cognitorum. Disposuit P. A. Saccardo.—In this Conspectus the carpological system of classification adopted in the first and second volumes of the Sylloge is applied to the Discomycetes. As the author invites criticism, it will be proper to make a few suggestions:

Instead of adding to Mitrula the colored species of Geoglossum with hyaline sporidia, it would seem more in accordance with the natural affinities of the species to remove from Mitrula to Geoglossum some of the species with clavate or subcylindric heads as suggested by Cooke in Mycographia. It may also be questioned whether it is well to found a genus on *color* alone, as appears to be the case with the proposed genus Microglossum. The propriety of adopting the genus Neolecta is also doubtful, differing as it does from Spathularia only in its globose spores. Helotidium does not seem sufficiently distinct from Helotium, nor does

Pirottæa seem necessary, differing from Mollisia only in its septate hairs scattered over the outer surface of the excipulum.

From the section Hyalodidymæ of Pezizeæ, Bisporella and Lanzia might be removed to Tapesia, Niptera to Mollisia and Helotiella taken back to Helotium, and under Sticteæ, Propolidium might be left under Propolis. To all these changes there can be no valid objection, except the uniseptate sporidia, and it would seem better to disregard this character than to remove these species from that place in the series where all their other characters would naturally seem to place them. For the same reason it would be better not to separate Hæmatomyxa from Hæmatomyces.

These suggestions are made merely as the expression of my opinion and not in any dictatorial spirit, knowing that each must do his work in his own way. Meanwhile, thanks are due to the learned mycologist of Padua for having condensed and made accessible the scattered literature of the Pyrenomycetes in the two volumes of the Sylloge already published, and it is certain that the succeeding volumes will meet with a ready welcome.—*J. B. Ellis, Newfield, N. J., May 13, 1884.*

THE FLOWER OF THE GLADE MALLOW (*Napæa dioica*).—The glade mallow is a dicœcious plant. There are usually 15–30 anthers in the male plant, the filaments below being united into a solid column enclosing no styles, as is usual when the column they form is a hollow one. At an early date the anthers, then tinged with purple, burst from the small bud, showing the petals as a mere edging near the border of the calyx. Later, however, the petals grow more rapidly and cover the stamens as is usual

Fig. 1. Fig. 2. Fig. 3.

FIG. 1.—*Napæa dioica*, male flower. FIG. 2.—Female flower. FIG. 3.—Gynœcium of the same, showing the sterile filaments (*f*) surrounding the styles, also the nectaries (*n*) at their base.

in flowers just before anthesis. The styles never break from the bud in this way, but wait for the expansion of the flower. There are as many styles as there are carpels in the gynœcium, usually 6–10. Surrounding the styles are filaments usually without anthers or bearing small insignificant ones of no value to the plant. These plants are virtually unisexual and female, the male organs being ineffective. The plants, as said above, have the sexes separated so that insect agency becomes necessary for the fertilization of this species. I have noticed a middle-sized wasp effecting this process, but the infrequency with which such visits are carried out, and the few individuals usually found, together with the dicœciousness of the flowers, account for the incapability of this plant to compete with ordinary plants in its neighborhood.

A wasp generally starts with one cluster of plants, gathering the honey until it has visited all the flowers it cares to, these are apt to be all of one sex. Then it starts for another, which may happen to be of another sex. If so, its supply of pollen is much too small to fertilize many ovaries, and these visits are not numerous enough to accomplish a full fertilization. Generally but few seeds are capable of germination. The corolla is white, 8^{mm} across. — *Aug. F. Foerste, Granville, Ohio.*

BOTANY AT THE APPROACHING MEETING OF THE A. A. A. S.—It is desirable on many accounts that there should be a large attendance of botanists at the meeting of the American Association for the Advancement of Science in Philadelphia in September. The location of the meeting is favorable to a larger attendance than ever of those interested in the study of plants, and this, together with the Botanical Club of the Association organized last year at Minneapolis, will, without doubt, bring out many who have not lately attended the meetings. May we not urge upon every botanical reader of the NATURALIST that he arrange his affairs so as to be able to attend?

And may we not, also, urge that the botanists who come to the meeting, bring solid and *condensed* papers, both for Section F of the Association and for the Botanical Club?—*C. E. B.*

ERRATUM.—In the article on Red Clover in New Zealand, on page 629 (June number), line 13 from the top, should read, "That *red* clover does produce its seeds in this colony." The change of one small word entirely changed the meaning of the sentence.

BOTANICAL NOTES.—Professor C. R. Barnes records and figures in the May *Botanical Gazette* the occurrence of cork between the annual layers in the stem of *Catalpa speciosa.* It is difficult to account for the presence of cork in such an anomalous position.——Two new species of Rubus (viz. *R. caldesianus* and *R. brachybotrys*), are described by W. O. Focke in the April number of *Nuovo Giornale Botanico Italiano.*——The last number (130) of the *Journal of the Linnean Society* contains articles of unusual interest, several of which we hope to present in summarized form ere long. They are as follows: *Alnus richardsoni*, a fossil fruit from the London clay; On the origin of placentas in the tribe Alsineæ of the order Caryophylleæ; Reproduction of Zygnemaceæ; Structure of the Stem of *Rhynchopetalum montanum;* Development of Starch Grains in the laticiferous cells of Euphorbiaceæ; The Organs of Secretion in the Hypericaceæ.——We have examined the little volume on "Flowerless Plants," by D'Anvers, which constitutes No. IV. of Putnam's "Science Ladders." It would serve excellently in the hands of an intelligent teacher as a reading book for children in the public schools. It is to be regretted that there are so many errors and slips here and there throughout the book. It needs to be re-edited.——The "Times of Linnæus" is the botanical title of an unbotanical book lately brought out by

Jansen, McClurg & Co., of Chicago. It is a pleasantly written romance, but it contains very little about Linnæus, and still less about botany.——Dr. Parry's paper on Chorizanthe, consisting of a revision and rearrangement of the annual species, first published in the Proceeding of the Davenport Academy of Sciences, has been republished in pamphlet form. It is a contribution of great value.

ENTOMOLOGY.

THE TRANSFORMATIONS OF NOLA.—The position of the genus Nola has long been an uncertain one. By some of the older authors, notably Hübner, the species were placed among the Pyralidæ, and Stainton in his Manual of British Butterflies and Moths regards the genus as forming "Family IX, Nolidæ" under the Pyralites, though he says: "One little group, the Nolidæ, is by many recent authors, and perhaps with reason, referred to the Bombycina, being placed with family Lithosidæ." The genus is now generally placed among the Lithosians. In our Synopsis of Bombycidæ we omitted to mention it, partly on account of want of specimens and partly perhaps from supposing it not to be a true Bombycid. Mr. Grote was the first American author to enumerate it in his New Check List of North American Moths, 1884, and to include it among the Lithosiæ.

Having reared *Nola ovilla*, my attention has again been drawn to its systematic position, which seems without much doubt to be properly among the Lithosiæ and near Clemensia.

I have found the larva frequently on the oak in September both in Maine and Rhode Island. Its habit is unmistakably Lithosian; it differs however from Arctian and Lithosian larvæ in having one less pair of abdominal legs, having but four pairs, whereas the caterpillars of the Lithosiæ and Arctians have an additional pair, *i. e.*, ten abdominal legs in all.

When I first discovered the larva of *Nola ovilla* I supposed it to be near Crocota. It was found to be common on the leaves of the oak in Maine, Sept. 6th.

The body is broad and much flattened, rather short, with four pairs of well developed abdominal feet; the first pair being situated on the fourth abdominal segment. The head is not very large, three-fourths as wide as the body; black, with a few paler irregular lines. The body is dirty-whitish, with a dark linear dorsal line, a dark dorsal discoloration behind the head, another in the middle of the body, and a third near the end.

The body is hairy, though not densely so; on each segment are four dorsal tubercles from which radiate short dusky hairs; on the side is a larger and longer tubercle from which arise lateral very long hairs, being as long as the body is broad; some black hairs are mixed with the dirty-whitish ones. The larger and most of the shorter hairs are simple, not barbed, but the shortest, smallest hairs are finely though slightly barbed, the barbules short.

The tubercles are dirty-white, concolorous with the rest of the body. Length 13mm.

Sept. 14–16 the caterpillars made singular boat-shaped flattened oval cylindrical cocoons closely attached to the surface of the leaves; they were spun with silk, but covered closely on the inside with bits of oak leaves. The pupa appeared as soon as the cocoon was completed, Sept. 15. The moths appeared May 31 and June 1 of the following year.—*A. S. Packard, Jr.*

An African Social Caterpillar.—At the meeting of the Linnean Society of London, of March 20th, Lord Walsingham exhibited a large and remarkable nest of a species of Anaphe from Natal, containing a packed mass of cocoons, with specimens of the moth and her larvæ. The nest and living larvæ were received in August. Many of the larvæ remained in the nest, but others, in companies of from twenty to forty, occasionally marched out, moving in closely serried ranks, much after the manner of the larvæ of the procession moth. From December to February about 250 moths emerged, but from the difficulty of obtaining their natural food, all died, though a pair bred and the eggs hatched. The mature insect closely resembles the *Anaphe panda* Boisd., though under the latter name, it would seem, there are several well marked local races. The genus is found in West Africa as well as Natal; and it appears that in the several species the color, size, shape, and material of the common nest, as well as the individual silky cocoons, markedly differ. The species of Anaphe have been brought from Old Calabar, Angola, Natal, Gold coast and the Cameroons.

Antennæ of a Beetle used as Defensive Weapons.—The genus Scorpionus (Cerambycidæ) of coleopterists, is so called on account of the peculiar shape of the last joint of the antennæ somewhat resembling the tail of a scorpion. I have met with a number of Brazilian species, all of which are broad, somewhat flattened, very rugose insects; the largest are nearly an inch and a quarter long and half as wide across the elytra. They are nocturnal, or crepuscular, in their habits, clinging to rough barked logs during the day; their rugose forms and sober tints harmonize so well with the surface that they are almost invisible.

While engaged in collecting near Rio de Janeiro, I found one of these beetles clinging, as usual, to the lower side of a log. Seizing it with my forefinger and thumb, I was about transferring it to the collecting bottle, when, to my surprise, it inflicted on me a pretty sharp sting or prick, which caused me to drop it quickly. In defending itself thus, the insect used its antennæ, spreading them out and then throwing them backward and upward with a strong jerk, so as to strike my finger and thumb just behind the nails with the scorpion-like terminal joint. I tried the experiment many times with this and with other specimens, and always with the same result; I have also noticed it in other species of the

genus. The little wound produced by the insect caused a slight swelling and irritation, much like a mosquito bite, for an hour or two. Possibly this arises from a poisonous exudation from the surface of the joint; so far as I can discover there is no true poison gland.

I have never heard nor read of any case where the antennæ of insects were used as defensive weapons, and the fact appears to me to be of much interest. Many beetles have antennal spines, which are perhaps used for a like purpose. Certainly the femoral spines of allied species are defensive arms, and pretty formidable ones, as every entomologist knows who has tried to catch the insects with his fingers. So are the thoracic spines of many Cerambycidæ, the femoral spines of certain large moths, the cephalic and thoracic horns of Scarabæidæ, and so on.—*Herbert H. Smith.*

Polymorphism of Male Lucanidæ.—At the meeting of the London Zoölogical Society for Dec. 18, 1883, Dr. F. Leuthner read an abstract of a memoir which he had prepared on the Odontolabini, a sub-family of the coleopterus family Lucanidæ, remarkable for the polymorphism of the males, while the females remained very similar. The males were stated to exhibit four very distinct phases of development in their mandibles, which the author proposed to term "priodont," "amphiodont," "mesodont," and "telodont." These forms were strongly marked in some species, but in others were connected by insensible gradations, and had been treated as distinct species.

Report of the Entomologist of the U. S. Department of Agriculture for 1883.—Professor Riley's report is shorter than his last year's, the limits being so restricted as to somewhat modify the original plan of the report and oblige him to omit a report on insects injurious to the cabbage, except mention of those caterpillars more specially injurious. The special agents in the Southwest are the same as the year previous. Professor A. S. Packard, Jr., supplies a report on the causes of the death of the spruce, fir and larch in northern New England, illustrated by two plates, one color showing the transformations of *Nematus erichsonii* and of *Tortrix fumiferana, Gelechia abietisella*, n. sp. and *Nematus integer* Say, which lives on the spruce. Mr. H. G. Hubbard has continued his work at Crescent City, Florida, where he is studying the insects affecting the orange, and reports on experiments on scale-insect insecticides. Mr. Bruner made in the summer of 1883 an extensive journey from New Mexico to Montana seeking facts relating to the Rocky Mountain locust. Among the other collaborators of the Entomological Bureau are Dr. S. W. Williston, who is working up the Syrphidæ and Tachinidæ, two families comprising insects so useful to the farmer; and Mr. John B. Smith, who is engaged on the insects injurious to the hops and cranberry, as well as a monograph of the Noctuidæ.

Besides notes on the silk-worm industry, insects injurious tc

the cabbage, the imported elm-leaf beetle is noticed at length, as well as the lesser locust (*Caloptenus atlanis*) which was destructive last summer in New Hampshire. The account of experiments with insecticides and the machines devised and figured by Dr. Barnard render the report one of high practical interest.

ENTOMOLOGICAL NOTES.—J. Chalande in an article on sensibility in blind cave-beetles (Anopthalmus) in the Bulletin of the Toulouse Society (XV, 1882), concludes with Piochard de la Brulerie, that their sensibility resides in their hair and is proportioned to the amount of this covering. The species of Anopthalmus are less exclusively cave-frequenting insects than has been supposed. In the United States, on the contrary, no Anopthalmi have been found out of caverns.——The insects affecting the strawberry are described by S. A. Forbes in a chapter of fifty-two pages in the Transactions of the Wisconsin State Agricultural Society, Vol. XXI.——E. Hoffer has published a paper on the habits of European humble bees (M. T. Ver. Steierm, 1881, Zoöl. Record for 1882), in which he states that the old queen lays eggs which produce all sexes; those of the so-called small females produce only females and workers. He also speaks of the trumpeter, who rouses the nests in the morning.——According to Dimmock (*Psyche*, III, 392), Witlaczil (Arbeiten Zool. Inst. Wien, 1882, 1–45), maintains that the so-called honey dew of Aphides exudes from the vent, rather than the cornicles. Dr. H. D. Walker takes the same view in his "Notes on Aphides" in Bulletin of the Buffalo Naturalists Field Club, I, No. 6, remarking that the cornicles "have generally been regarded as furnishing the honey dew of which the ants are so fond. This, however, I am satisfied from many observations, is not the case. The honey dew is simply the natural excretions of the insect. I am not aware that the use of these tubes is positively known." In the same article Dr. Walker notices pulsating organs in the legs of Aphides, like those described by Mr. Locy in the aquatic Hemiptera.——James Winters, a farmer, was stung to death by buffalo gnats near Helena, Arkansas, last spring. While he was at work in a field, the gnats swarmed up and enveloped him. Their stings becoming unbearable, he started for home at full speed. All remedies failed to relieve him, and he died in a short time in great agony, his face and neck having turned almost black. This is taken from a reliable newspaper exchange. The buffalo gnat is a species of Simulium, or black fly. They have been known to worry horses to death. (See NATURALIST, Vol. II, p. 590).——Sir S. S. Saunders, who died April 15, was an English entomologist well known for his thorough work on the Strepsiptera and fig-insects.——It seems that the Ray Society has acquired the drawings of the late Wm. Buckley of British caterpillars and his voluminous MSS. for publication. They will probably form the subjects for three or four volumes. Those entomologists (not already members of the Ray Society),

who wish to obtain these volumes, should send in their names to the Secretary, Rev. T. Wiltshire, 25 Granville Park, Lewisham, London, S. E., England. We regard the publication of these sketches and descriptions as a great boon to American entomologists, in default of good figures of native larvæ.——At the meeting of the London Entomological Society, October 3, Mr. Wailly exhibited a Samia allied to *S. cecropia*, and possibly a hybrid between it and some other (unknown) species.——"The Butterflies of Maine" by Professor C. H. Fernald, is rich in new facts regarding the distribution and habits of these insects. It is rather startling to read of the occurrence of *Chionobas jutta* at Orono and of *Terias lisa* in the Isle of Shoals, *Euptoieta claudia* near Portland, and *Junonia coenia* near Bangor. Sixty-nine species are enumerated.——Dr. Heylaerts has nearly ready for publication a monograph of the Psychides of the world. In the *Compte-rendu* of the Entomological Society of Belgium, besides notes on European species, he describes four new species from the Argentine Republic, and also a new Cossus-like genus from Chirequi, under the name of *Romanoffia imperialis*.——In his paper on North American Papilionine and Nymphalinine caterpillars published in the Jena *Zeitschrift*, Professor A. Gruber carries on the work begun by Weismann in his great work on seasonal dimorphism, and describes and figures five stages of the larvæ of *Papilio asterias* and five of those of *P. turnus*, five of *P. troilus* and four of *P. ajax*, and five of *P. philenor;* of the Nymphalines four stages of *Melitæa phaëton*, three of *Melitæa marcia*, three of *M. nycteis*, two of *Argynnis myrina*. The paper closes with some general remarks; it will greatly interest American lepidopterists. The sketches alone tell a striking story.

ZOÖLOGY.

THE LIFE-HISTORY OF THALASSEMA.—Mr. H. W. Conn publishes, in the studies from the Biological Laboratory of Johns Hopkins University (Vol. III, No. 1), an abstract of his researches on the early stages of this Echiurid worm. The species under observation he regards as new, and mentions it under the name of *Thalassema melita;* it is of a dull red color, with a light yellow preoral lobe. It has the habit of seizing upon empty sand dollars and making its home in them. It enters the mouth of the shell while very small, but once within it grows to a considerable size, and remains the rest of its life a prisoner.

The most important points observed are the following:

1. The origin of the ova and spermatozoa as modified peritoneal cells; their growth in the body-cavity, and their preservation in a sexually mature condition in the sexual pouches.

2. Protrusion of two polar globules exhibiting a rhythm precisely similar to that of the segmenting ova.

3. Segmentation, which is, exceptionally among Annelids, perfectly regular.

4. Formation of gastrula by a typical invagination.

5. The early appearance of a preoral band of cilia and its subsequent disappearance and replacement by a *row* of longer, more powerful cilia.

6. The transformation of the gastrula into a trochosphere by a peculiar method of growth.

7. Origin of mesoderm as two-fold, and the segmentation of mesodermal bands.

8. Origin of ventral nerve chord from the ectoderm as a bilateral structure.

ANATOMY OF THE STOMACH OF STALK-EYED CRUSTACEA.—This subject, lately treated by E. Nauck, is being discussed in a more extended manner by F. Mocquard in the *Annales des Sciences Naturelles*. As is well known the stomach of the Decapoda is armed at the pyloric end with numerous calcareous pieces which project into the cavity and constitute, in the author's opinion, a powerful apparatus for the trituration of the food, while the membranous invaginations give rise to a more or less complicated valvular system. Nauck, who published his paper in the *Zeitschrift für wissen. Zoologie*, described the gastric skeleton alone of the crabs, but Mocquard extends his investigations to all the stalk-eyed Crustacea, and also studies the muscles and stomachic nerves. The figures already published appear to have been carefully and clearly drawn. Meanwhile, F. Albert has an illustrated article on the same subject in the *Zeitschrift für wissen. Zoologie*, published Dec. 21, 1883.

THE CRAYFISH NOT DIMORPHOUS.—It has long been supposed that the species of Cambarus were dimorphous, there being two sets of males, differing mainly in the shape of the first pair of abdominal appendages. But in a paper published in the *American Journal of Science* for January, Professor Walter Faxon states that he received a lot of living *Cambarus rusticus* from Kentucky, males of the "first form" and females, which bred freely in confinement. After pairing, three of the males moulted. These soft-shelled individuals were found to be of the "second form;" their exuviæ of the "first form!" After attaining the "first form" and after pairing, the same individual has reverted to the "second form." It is now clear that we are not dealing with a case of true dimorphism, such as is well known among insects and plants, but it appears probable that the two forms of the crayfish are alternating periods in the life of the individual, the "first form" being assumed during the pairing season, the "second form" during the intervals between the pairing seasons. It is to be inferred that before the animal is again capable of reproduction, another moult will bring it again into the "first form." Professor Faxon observed the same fact in *C. pro-*

pinquus, a male specimen having been taken in the act of moulting. Faxon adds, that "such a change as this connected with the reproductive period is unparalleled, so far as I know, among the invertebrata; and even among the vertebrata, the cases of partial atrophy of the generative organs or shedding of antlers (as in the stag) after the rut is over are hardly comparable."

THE GLOTTIS OF SNAKES. — In the January number of the AMERICAN NATURALIST, Dr. C. A. White, of the National Museum at Washington, gave some highly interesting illustrations of the peculiar structure of the epiglottis that he had observed in the bull snake (Pityophis), and to which he attributes the loud, hoarse, "bellowing" sort of "hiss" for which this snake is remarkable. The individual which he examined is still alive, occupying a distinguished and exclusive position with two or three other snakes at the museum, and it amiably submitted to have its mouth held open while Dr. White kindly exhibited to me the very singular character of its epiglottis. It differs so obviously from that of any other snakes which I have had an opportunity of examining, that I venture to offer a few words to describe my own observations.

Dr. White thinks that as in snakes there is no comminution of food, any protection of the aperture of the wind-pipe in swallowing is unnecessary. In Pityophis the permanently erect position of what represents the epiglottis would certainly appear to be a sufficient protection, but in some others that I have watched while feeding (for the wind-pipe is often so far forward as to be easily observed), the glottis is closed tightly and remains closed, except when occasionally opened as if for the purpose of respiration and closed again; and the action appears to be entirely volitional, not regular, but as occasion requires. The impression imparted to the observer is, that the action is protective also; there is a sensitiveness and nervousness, so to speak, about the contracting and expanding orifice, as if the snake were guarding against the entrance of dust or any foreign substance while the trachea is in this exposed position, opened to breathe only, and quickly closed at will. When at rest and the snakes are not feeding, we see the anterior part of the windpipe lying along the mouth, somewhat in the form and position of a parrot's tongue; and in some small snakes you may occasionally discern the cartilaginous rings of the trachea through the delicate membrane. The orifice in those snakes that I have watched appears to be of a more simple construction than in Pityophis, and the epiglottis described and illustrated by Dr. White is either entirely absent or represented only by a slightly developed lip or valve at the lower part of the orifice, and called by Duméril a *petite languette*, which assists to more thoroughly close the glottis.

Dr. White informs me that he has not watched Pityophis while

feeding, and cannot, therefore, tell whether the trachea protrudes from the mouth or not at that time. I hardly see how it can, with this stiff, erect barrier immediately in front of it to guard the opening, as when Dr. Yarrow and myself saw it expand. Indeed this protrusion of the trachea in snakes appears to be but little known; for notwithstanding their abundance in the woods in America, you do not often come upon a snake feeding, and zoölogical collections are at present few and far between. Nor does a snake invariably require to breathe while swallowing. During the many hours I have spent in watching the snakes on feeding days at the London Zoölogical Gardens, week after week for several years, I have seen the trachea protrude from the mouth perhaps once in a dozen meals. When the food is quickly and easily swallowed, the supply of air in the lungs is sufficient for the time; but should the prey be unusually bulky or awkward to manage, completely gorging the mouth, it may occupy a longer time to swallow, when to breathe afresh becomes requisite, and the difficulty is met by this adjustable wind-pipe. Not unfrequently a snake is an hour or more swallowing large-sized prey, during which time the mouth and throat are stretched to their utmost capacity, and then you may see the trachea projecting a full inch in the larger kinds. In chap. VIII of my work on "Snakes" I have entered more fully into the subject than space will here permit. Professor Owen describes the apparatus as the *glottis*, other writers speak of it as the *larynx*, while others again simply state that the *wind-pipe* may project beyond the mouth. I have observed it in the large oriental constrictors, the rattlesnakes, several of the African vipers, and even in some small snakes, as, for instance, *Heterodon d'orbignii* and the English ring snake; who in both cases were swallowing an inconveniently large frog, and the trachea was sufficiently forward to show the contracting and expanding action of its orifice. We hope to persuade Pityophis to partake of a meal while we are watching him, when there may be further observations to record. —*Catherine C. Hopley.*

Abnormal Deer Antlers from Texas.—The accompanying photographs of the skull and antlers of a deer were sent me from San Antonio, Texas, by Dr. Mortimor Slocum, with the information that the deer was killed by a hunter named Havey, on the Neuces river, about one hundred miles west of San Antonio, in August last, while the velvet was yet on the antlers; that the deer weighed 180 pounds, and that a companion was with the deer with antlers precisely the same as these. These antlers are fourteen inches long, and eight and a quarter broad, with seven points at each of the ends, and both are very much alike. This is the sum of the information given me of these remarkable antlers, and I am requested to classify the deer specifically.

These antlers are now in the collection of Mr. Dosch of San

Antonio. I examined this collection several years since, and must pronounce it the finest collection of deers' heads and antlers I ever saw anywhere; most of these were well mounted, and well arranged. Nearly all are of the common deer (*Cervus virginianus*) and taken in Texas; but there were one or two of the mule deer (*Cervus macrotes*) which I was informed were also taken in Texas.

With the limited information before me it is not easy to classify this specimen with absolute certainty. If I had but the tail or the skin of a hind leg I could classify it with as much certainty as if the whole animal was before me, for these are so nearly alike on every individual of each species and so unlike every other species as to be absolutely reliable, so far as my observations have extended.

The first inquiry which naturally presents itself is, are these antlers of the form and position of any known species of deer in America? The palmetation first attracts our attention. We have three species of deer in America, which have habitually and distinctively palmetted antlers, the moose (*Alces*) and the two species of caribou (*Tarandus*).

These antlers most resemble that of the moose, being broadly palmetted, with points or spurs on their upper borders, but in position they are entirely unlike those of the moose. The antlers of the moose are projected from the head in a nearly horizontal position, sometimes a little depressed, and sometimes a little elevated, the latter position being more frequently observed on the young animal. The palmetation does not become pronounced till after he is four years old.

The position of these antlers appears to be approximately vertical, spreading, possibly, thirty degrees from the vertical.

Not the rudiment of a basal snag is formed on the antler of the moose. On these antlers the basal snags are large.

The form of these antlers differs still more widely from those of the caribou. These always have distinctive beams with long prongs which are liable to be palmetted at the ends, but the most distinctive characteristic is the brow tines which project downward over the face, with broad vertical palms at the ends, with spurs or fingers which approach each other, and which sometimes interlock like the fingers of two hands.

Indeed there can hardly be said to be a resemblance between the antlers under consideration and those of the caribou.

But if the resemblance to either were never so striking, the latitude in which the animal was found would forbid the suggestion of a relationship to either the moose or the caribou. All of these are boreal animals, occupying high northern latitudes. Maine and Montana may be considered the extreme southern limits of their habitat. I have seen fossil remains of the moose found as far south as Chicago, and I have met with statements that they have been found as far south as the Ohio river, but the live animals have not occurred in these regions within the historic period.

We may safely conclude that this deer is not a relative of any of the known species of deer which have habitually palmetted antlers. By no accident, or stress of circumstances could any of these northern species have been found as far south as Texas, and that, too, in the summer season.

Is it a new species hitherto unobserved with normal antlers like these? If a distinct species, it must be more or less numerous and habitual either in the region where it was found or in some other region whence it was possible for it to have wandered.

Now, this entire continent has been so thoroughly worked over during the last half century by competent naturalists, to say nothing of more numerous hunters, who do not overlook anything new or unusual, that so large and so distinctive an animal as this could not possibly have escaped observation. We may expect to find new species of birds whose habits are migatory, or possibly some small and nocturnal quadrupeds, but so large an animal as this deer, with antlers so peculiar and distinctive as to attract the attention and even wonder of every beholder, could not have escaped detection. It is impossible to believe that there is a whole race of animals anywhere on this continent habitually wearing such antlers as these, else they would have been seen before somewhere. We are forced, then, to the conclusion that this deer was not the representative of a new species of deer, but an individual of some well-known species, with peculiar and abnormal characteristics confined to the individual. But Mr. Havey says, there was a companion to this deer, with antlers precisely like these. Well, two bucks will not make a species, but may there not possibly be some error in this observation? Had he killed the other buck also, and critically compared them when lying side by side, we might not question the accuracy of his observation, but his view must have been taken when the deer was in life, standing at a greater or less distance off or when running, and whether there were intervening objects to impair the value of his observation we are not informed.

We need further information before we can determine what value we can place upon the opinion that both sets of antlers were precisely alike.

I am clearly of opinion that these antlers are of an abnormal growth, probably induced by some accident or violence inflicted upon the pedicels of the antlers, or upon the antlers themselves while growing in their early stages. Such accidents and consequently abnormal growths are not very uncommon. At p. 226 of "The Antelope and Deer of America," I give an illustration of the antlers of a common deer, showing as wide a departure as these from the normal type though of an entirely different character. That growth was undoubtedly induced by violence done to the antlers in the early stages of their growth. In that

case as in this, the injury was to both alike and doubtless at the same time.

Evidence of a serious injury to this deer is not wanting, even in these photographs. In the side view we distinctly see a pronounced disfigurement in the nose or face below the eyes, or what we call in a horse a Roman nose. Now this never occurs naturally in any of the deer family, and so we may safely conclude that this deer had suffered serious violence in or about the head, and this I think the most probable explanation of the cause of these abnormal growths of the antlers.

This deer must have belonged to one of two species of deer. The Virginia deer is the most common species in that part of

Antlers of a deer shot in Texas.

Texas where this deer was found. The mule deer is occasionally met with in Texas, though its occurrence is not very common. If the ears were small, the tail flattish and of a lanceolate form, and covered with white hairs on the under side and edges, and the naked black portion, covered with the reversed hairs which overlay the metatarsal gland on the outside of the hind leg, was not much more than one inch long and surrounded by a border of white hairs, then we should know certainly that it was a common Virginia deer though of twice the average size of this deer in Texas. If the ears were very large and heavy, the tail round and naked on the under side, covered else with white hairs except a black switch or tuft at the end, and if the naked black portion over the metatarsal gland was three or four inches long with no

white hairs about it, then we should certainly know it was a mule deer. These tails are illustrated in the work above referred to, on p. 234, and the glands on p. 254. But these indicia of species are entirely wanting, and we only have a picture of these abnormal antlers to enlighten us. If the antlers were normal we might determine the species with considerable confidence.

The antlers of the common deer are usually less spreading than those of the mule deer, though not always so, and in this respect these answer best to the former, though their position may have been altogether changed by the accident. The strongest evidence to show that it was a common deer I see in the basal snag near the butts of each antler; these are very large and both bifurcated. This snag is always present on the normal antler of the Virginia deer, and is usually present on that of the mule deer, but is very much smaller on the latter than on the former.

On the common deer this member is frequently bifurcated on large old specimens but never on the mule deer, though on large specimens we frequently see a rudimentary branch, but I have never seen anything like an equal bifurcation or even a fairly developed tine. But the bifurcations of these prongs are not as we see them in the natural growth. The prong divides into nearly equal parts very near its base and these separate at angles of seventy degrees or so. In the few cases where I have seen the basal snags fairly divided into approximately equal parts, the forks have grown up nearly parallel, but when the antler itself is so disfigured as this we should not expect any member to be in its natural form. It is the unusual proportionate size of this nasal snag which inclines me to attribute the specimen to a Virginia deer.

The size of the deer suggests a larger species than the common deer, which, as already suggested, is very considerably smaller in Texas than in higher and colder latitudes, but I have no doubt still larger specimens than this is claimed to be are occasionally met with in that country.

The mule deer is an appreciably larger species than the common deer, and hence, the large size of this specimen suggest this deer, but I can point out no other evidence which strongly indicates the mule deer; while the rarity of this species in the country where this was killed, and the abundance of the common deer suggests the latter as most probable.

I would give something for the ear or the tail of this deer that all doubts might be resolved; as it is I cannot tell to which of these two species this deer belonged from the mere picture of a damaged head and antlers of an unnatural growth. It is easier to tell what it is not.—*J. D. Caton.*

[*Note by the Editor.*—The case above cited by Judge Caton is paralleled by a similar one which came under my observation

several years ago. A large and highly colored buck of the *Cariacus virginianus* was shot in Central New Jersey, in which the horns of both sides were completely and symmetrically palmated as in the moose. This modification of horns of Cariacus is just what is to be expected in accordance with law of "acceleration," and constitutes an actual transfer of such modified individuals to the genus Alces. The genera Alces and Cariacus agree with other American deer in the absence of the brow antler, and Alces stands at the head of the series by virtue of its palmation. If a similar change were to take place in a true deer of the genus Cervus, the result would be a Dama, a genus which agrees with Cervus in the possession of a brow antler, and differs from it as Alces does from Cariacus, *i. e.*, in its palmation. Instances of this kind show the correctness of the position I took in 1868,[1] that the change of generic characters is independent of that of the specific, and that one species may come, by acceleration in some of its individuals, to belong to two genera.—*E. D. Cope.*]

Forsyth Major on the True Pigs.—In the *Zoologischer Anzeiger*, June, 1883, the above well known palæontologist gives an account of the recent species of true pigs with their extinct connections. He limits the existing species to three: *Sus verrucosus* M. and S. (Java, Celebes), *S. barbatus* M. and S. (Borneo), and *S. scrofa* L. He regards the *S. vittatus* M. and S. as a form of *S. scropha*, and finds that it has seventeen synonyms. These often represent minor variations of character, which do not form constant combinations. They are, as a whole, characteristic of immature conditions of the *S. scropha* of northern regions. Forsyth Major regards the *S. vittatus* as the primitive form. The *S. verrucosus* is nearly related to the *S. giganteus* Falc. of the Siwaliks, and the *S. strozzii* Menegh. of the Val d'Arno.

Zoölogical Notes.—*Mollusks.*—H. L. Osborn (Stud. Biol. Lab. J. Hopk. Univ.), gives the results of his studies of the gills of some prosobranchiate mollusca. Starting with the statement that the researches of Peck and Mitsukuri have made it tolerably clear that the highly complicated gills of some lamellibranchs are derivable from a simple series of folds of the body wall, he summarizes thus: "The gill of Chiton and Fissurella is closely like the ctenidium which Lankester considers the primitive type of molluscan gill. In ctenobranchs, almost universally, the gill is not a ctenidium, but a very much simpler organ. Its form compares closely with the gill which we have come to regard as the primitive lamellibranch gill." He inclines to the belief that the lamellibranchiata are degraded from cephalophorous ancestors, while their highly complex gills are due to "the sessile habit of the animal throwing upon the gills sundry functions besides those of the gill proper.

[1] In "The Origin of Genera."

Crustacea.—H. W. Conn (Studies from the Biological Laboratory, Johns Hopkins Univ.), contributes some thoughtful observations and suggestions upon the signification of the larval skin with which the decapod zoea is covered on emerging from the egg. The apparent anomaly that certain low Macrura possess larvæ with a thorax, while the Schizopods have a zoea without a thorax, is explained by the assumption that the zoea stage is an intercalated adaptive form with the body shortened to enable the larva to swim better, while the protozoea, represented by the zoea of Penæus, is the ancestral form. By substituting the Protozoea for the Phyllopoda, Mr. Conn seeks to reconcile the classification of Boas with that of Packard, and with the teachings of embryology. ——Professor Greeff (Sitz. Ges. Natur. Marburg, 1882), gives an account of the land and fresh-water crabs of St. Thomas and Rolas, in the Gulf of Guinea. *Gecarcinus ruricola*, known from the West Indies, occurs also in incredible numbers in the Guinea islands. It is found even in the mountains, under stones, in holes in the earth, and other damp places. *Cardisoma guanhami*, another Antillean species, occurs with the former. *Cœnobita rugosa* is common all over St. Thomas, and causes a great mixture of marine and fresh-water shells. During their growth the crabs wander inland, taking with them Murices, Bullidæ and other marine forms. Arrived at the mountains, 800 meters above the ocean, they exchange these for Helix and Achatina in which they travel to the coast. The fresh-water species are *Palæmon olfersi*, *Atya scabia* and *Thelphusa margaritaria*.

Fishes.—On account of the possession of a drag-net adapted for the purpose, the *Talisman* was more fortunate than any previous exploring vessel in obtaining examples of deep-sea fishes. At one haul in 16° 52′ N. lat., and 27° 50′ W. long., and at a depth of 450 fathoms, no less than 1031 specimens were taken. The greatest depth at which a fish was obtained was 4255 meters, and the fish was *Bythites crassus*. Some of the species appear to inhabit very extensive zones of depth, thus *Alepocephalus rostratus* ranges from 868 to 3650 meters, *Scopelus maderensis* from 1090 to 3655 meters, *Lepioderma macrops* from 1153 to 3655 meters, and *Macrurus affinis* from 590 to 2220 meters. This great range appears to indicate a power of adaptation to the pressure of the water. Among the phosphorescent apparatuses found in these denizens of the deep, one of the strangest is that of *Eustomias obscurus*, a slender fish with a large mouth. From the under side of the chin depends a long filament ending in a rayed knob which is highly phosphorescent.——A. Cocco (*Il Naturalista Siciliano*), contributes some interesting notes on *Trachypterus cristatus* Bonelli, and describes it from an example 132 millimeters long, taken in the Straits of Messina. The six rays of the first dorsal greatly exceed the body in length.——G. Seguenza (loc. cit.), notices the occurrence of *Rhinobatus halari* in the seas

of Sicily. The species was described by Ruppel from the Red sea, but has been taken at Palermo and on the Algerian coast. It attains the length of six feet.——The Marchese A. De Gregorio (*Il Nat. Sic.*, March), continues his notes on the Jurassic corals of Sicily, and describes four new species.——Miss Rosa Smith (Bull. Col. Acad. Sci., 1884), describes *Squalius lemmoni*, discovered by Mr. J. G. Lemmon in Rillito creek, near Tucson, Arizona.——Professor Greeff (Sitz. Ges. Natur. Marburg) describes *Gobius bustamentei* from St. Thomas.

Reptiles.—Dr. Strahl (Sitz. Ges. Bef. Natur. Marburg, 1882–83) describes the development of *Lacerta agilis, vivipara* and *viridis*, especially of the latter. The allantois, the changes in the ovum and the formation of the vascular system in the germinal disk, are given at length.

Mammals.—Professor Lieberkuhn (Sitz. Ges. Natur. Marburg, 1882), gives the results of his researches into the development of the ovum and embryo of the porpoise; and in the same proceedings, 1883, discusses the formation of the medullary canal in mammals generally.

PHYSIOLOGY.[1]

Coloring Matters of Bile.—C. A. MacMunn is led by his observations to dispute a generally accepted view that the liver of invertebrates is nothing more than a pancreas in function; the most striking outcome would seem to be the discovery of the wide distribution of a coloring matter, which is beyond doubt a chlorophyll pigment; this it is proposed to call entero-chlorophyll. The author has chiefly relied on the evidence afforded by the spectroscope, for, as he points out, it is useless to expect that the chlorophyll in the state in which it occurs should be capable of developing oxygen in the presence of sunlight in the livers of Mollusca, or in the pyloric cæca of star-fishes, &c. The new body would appear to differ from plant-chlorophyll in that treatment with nitric acid makes the solution slightly greenish, although previously it may have been yellow. This is explained by the view that the pigment is in a more or less reduced condition, "probably due to the action of a ferment on the chlorophyll, or to the fact that it is sometimes present in the form of a radical or chromogen."

Spectroscopic measurements show that the liver of the oyster contains a coloring matter which, when treated in alcholic solution with nitric acid, gives the same spectrum as a similar solution of leaf-green when treated with that reagent. A large number of other Mollusca have been examined.

Among the Arthropoda, Crustaceans have alone been studied; in the common crab enterochlorophyll was rarely, but lutein con-

[1] This department is edited by Professor Henry Sewall, of Ann Arbor, Michigan.

stantly found; in the crayfish there was abundance of hæmatin in the bile.

The pyloric cæca of star-fishes were found to function as a so-called liver; that is to say, they not only seem to prepare a digestive ferment, but they serve as organs for the storing and probably for the actual production of pigments for surface coloration; enterochlorophyll is here also found.

Hæmochromogen, which is found in the bile of the crayfish and of the Pulmonate Mollusca, is apparently due to an animal's mode of life, and does not seem to be "distributed according to morphological considerations."

It is as yet too early to speak definitely, but there is much evidence to show that enterochlorophyll is synthetically formed in the body of its animal possessor.

The second and third portions of this important paper deal with the vertebrate bile pigments, and some unusual urine pigments; the latter should be of interest to the physician as well as to the physiologist.—*Journ. R. Micr. Society, Dec., 1883.*

PSYCHOLOGY.

DARWIN'S OPINIONS ON INSTINCT.—A posthumous essay on "Instinct," by the late Charles Darwin, was read on December 6th, at the Linnean Society, before a very large and distinguished audience of fellows. The paper, which treated of the instincts of animals, and the bearing of the subject on the theory of natural selection, was originally written for the "Origin of Species," but never published. It discussed the migration of birds and mammals, and after narrating a great series of curious facts, concluded with the inference that though there were many aspects of the question which admitted of no immediate explanation, the migratory instinct was inherited from ancestors who had to compass (for the sake of food or other causes) long distances, when the conditions of land and water were different from what they are at present. He then considered how the more remarkable migrations could possibly have originated. Take the case of a bird being driven each year, by cold or want of food, slowly to travel northward, as is the case with some birds; and in time we may well believe that this compulsory traveling would become instinctive, as with the sheep in Spain. Now, during the long course of ages, let valleys become converted into estuaries, and then into wider and wider arms of the sea; and still he could well believe that the impulse which leads the pinioned goose to scramble northward would lead our bird over the trackless waters; and that, by the aid of the unknown power by which many animals, and savage men, can retain a true course, it would safely cross the sea now covering the submerged path of its ancient land journey. Animals on oceanic islands, and other localities where they have never met with man or beasts of prey, are devoid of fear. This instinc-

tive dread they subsequently acquire, for their own preservation, and transmit it to their descendants. At the Galapagos islands Mr. Darwin pushed a hawk off a tree with the muzzle of his gun, and the little bird drank water out of a vessel which he held in his hand. But this tameness is not general, but special towards man; for at the Falklands the geese build on the outlying islands on account of the foxes. These wolf-like foxes were here as fearless of man as were the birds, and the sailors in Byron's voyage, mistaking their curiosity for fierceness, ran into the water to avoid them. In all old civilized countries the wariness and fear of even young foxes and wolves are well known. At the Galapagos islands the great land lizards (Amblyrhynchus) were extremely tame, so that Mr. Darwin could pull them by the tail; whereas in other parts of the world large lizards are wary enough. The aquatic lizard of the same genus lives on the coast, is adapted to swim and dive perfectly, and feeds on submerged algæ; no doubt it must be exposed to danger from the sharks, and consequently, though quite tame on the land, he could not drive them into the water; and when he threw them in they always swam directly back to the shore. Animals feigning death seemed to Mr. Darwin a remarkable instinct, but he considered that there was much exaggeration on the subject. It struck him as a strange coincidence that the insects should have come to exactly simulate the state which they took when dead. Hence he carefully noted the simulated positions of seventeen kinds of insects (including an Iulus spider, and Oniscus) belonging to the most distinct genera, both poor and first-rate shammers; afterwards he procured naturally dead specimens of some of these insects, others he killed with camphor by an easy slow death. The result was that in no one instance was the attitude exactly the same, and in several instances the attitude of the feigners and of the really dead were as unlike as they possibly could be. Bird-nesting and the habitations of other animals were next discussed, the general conclusion being that though there are various adaptations of inherited instincts to suit varying circumstances, yet that these variations all tend to preserve the species in the struggle for existence, by conducing to the "survival of the fittest." Although he did not doubt that intelligence and experience often come into play in the nidification of birds, yet both often fail; a jackdaw has been seen trying in vain to get a stick through a turret window, and had not sense to draw it in lengthways; Gilbert White describes some martins which year after year built their nests on an exposed wall, and year after year they were washed down. The *Furnarius cunicularius* in South America makes a deep burrow in mud-banks for its nest; and he saw these little birds vainly burrowing numerous holes through mud-walls, over which they were constantly flitting, without thus perceiving that the walls were not nearly thick enough for their nests. After an exhaustive account of va-

rious traits of instinct, and difficulties in the way of his theory, explaining all of them, the paper closed with the following general conclusion:—"We have chiefly considered the instinct of animals under the point of view whether it is possible that they could have been acquired through the means indicated on our theory, or whether, even if the simpler ones could have been thus acquired, others are so complex and wonderful that they must have been specially endowed, and thus overthrow the theory. Bearing in mind the facts given on the acquirement, through the selection of self-originating tricks or modification of instinct, or through training and habit, aided in some slight degree by imitation, of hereditary actions and dispositions in our domesticated animals, and their parallelism (subject to having less time) to the instincts of animals in a state of nature, bearing in mind that in a state of nature instincts do certainly vary in some slight degree; bearing in mind how very generally we find in allied but distinct animals a gradation in the more complex instincts, which show that it is at least possible that a complex instinct might have been acquired by successive steps; and which, moreover, generally indicate, according to our theory, the actual steps by which the instinct has been acquired, inasmuch as we suppose allied instincts to have branched off at different stages of descent from a common ancestor, and therefore to have retained, more or less unaltered, the instincts of the several lineal ancestral forms of any one species; bearing all this in mind, together with the certainty that instincts are as important to an animal as their generally correlated structures, and that in the struggle for life under changing conditions, slight modifications of instinct could hardly fail occasionally to be profitable to individuals, I can see no overwhelming difficulty on our theory. Even in the most marvelous instinct known—that of the cells of the hive-bee—we have seen how a simple instinctive action may lead to results which fill the mind with astonishment. Moreover, it seems to me that the very general fact of the gradation of complexity of instincts within the limits of the same group of animals, and likewise the fact of two allied species, placed in two distant parts of the world, and surrounded by wholly different conditions of life, still having very much in common in their instincts, supports our theory of descent, for they are explained by it; whereas if we look at each instinct as specially endowed, we can only say that it is so. The imperfections and mistakes of instinct, on our theory, cease to be surprising; indeed, it would be wonderful that far more numerous and flagrant cases could not be detected, if it were not that a species, which has failed to become modified and so far perfected in its instincts that it could continue struggling with the co-inhabitants of the same region, would simply add one more to the myriads which have become extinct. It may not be logical, but to my imagination it is far more satisfactory to look at the young

cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of the Ichneumonidæ feeding within the live bodies of their prey, cats playing with mice, otters and cormorants with living fish, not as instincts specially given by the Creator, but as very small parts of one general law leading to the advancement of all organic bodies—Multiply, vary; let the strongest live and the weakest die."

DREAMING IN VERSE.—Having a turn of mind for rhyming, I had frequently dreamed in verse. On one occasion my husband heard me repeat distinctly two lines in verse. He asked me very gently, "What is the next line?" I replied, in my sleep, "You guess the next line, and I will tell you the last." His merry laugh awoke me and, curiously enough, I could not recall my dream or the lines which I had spoken aloud.—*Mrs. Prof. T. H. Rich, Bates College, Me.*

ANTHROPOLOGY.[1]

MR. BANCROFT'S NEW VOLUMES.—Scarcely a week passes in which the editor of this department of the NATURALIST is not importuned with some such question as this, "What one work will give me the best account of ancient and modern Mexico and Central America?" To this question there can be but one answer. By far the best and most comprehensive account of that whole region is the monumental work of Hubert Howe Bancroft. We are not now discussing the style of the composition, abounding in metaphors which only show the enthusiasm of the writer. Neither are we saying that the author is always right—he himself, over and over again, admits that his ground is not firm beneath his feet. But looking at the cost, the intricate machinery of research, the painstaking, the unwearied and unswerving attachment to a single aim, and the scrupulous care to give to every man his due, we forget every little shortcoming. Let us dissect Vol. I of the new series. Pages I–XIV contain the preface, in which Mr. Bancroft sets forth the plan of his new series, defines his methods, credits his assistants, throws a lance at historical theorists, and, we regret, defies his critics. Then follows, pages XV–XXIII, analyses of the XXVII chapters into which the volume is divided. From page XXV to LXXII, in his characteristic manner, the author presents a bibliography of Central American literature, in which not less than 2000 titles are given. Some of these are the names of works for which large sums of money have been paid, and all of them have been thoroughly exhausted by the faithful corps of indexers employed by the author. The introductory chapter relates to the condition of Spanish society when Spain began her American conquests. At the close of the chapter is an encyclopædia of information on geographical knowledge and discovery prior to the year 1540,

[1] Edited by Professor OTIS T. MASON, 1305 Q street, N. W., Washington, D. C.

pp. 67–154. We pass over chapters II–XXII, devoted to the narrative of Columbus and his successors in Darien, Costa Rica, Nicaragua, and Honduras, and come to operations of the Spaniards in the provinces bordering on Mexico. The Quiché empire rose in the XII or XIII century of our era. In the early part of the XV century the Cakchiquels divided domination with them. In their turn the Zutugils separated from the Cakchiquels, having their capitals at Patinamit and Atitlan. The manner of conquest by which Pedro de Alvarado, the lieutenant of Cortez, and his faithful followers destroyed their power and appropriated their country, is the burden of the closing chapters of the volume. "Henceforth," says Mr. Bancroft, "oppression and destruction marched hand in hand over the country, and the result was a national and social eclipse of the fallen races. Their arts and sciences were soon forgotten; their architectural skill was lost; and from a state of happy development their life as a nation was blotted out."

The author designs to devote three volumes to Central America, therefore, in order to bring his Mexican studies along simultaneously, Vol. IV of the series, being the first on Mexico, follows Vol. I. The five periods of Mexican history as discussed by this writer, are (1) the aboriginal annals of Anahuac (Native Races, Vol. V); (2) the conquest of Cortez; (3) three centuries of vice-regal rule; (4) the struggle for independence and the founding of the republic; (5) her subsequent history, internal revolutions, war with the United States, the imperial experiment of Maximilian, and the later development of peaceful industries. For the performance of this work Mr. Bancroft is thoroughly equipped, indeed, no other historian has ever had at his command such resources. Furthermore it is not difficult to perceive that Mexico is the author's pet. The bibliography covers nearly a hundred pages of fine type, and this repeats not one-third of the works consulted. Not all the chapters in this volume are strictly ethnological, from our point of view, although they are certainly anthropological. The interest for the student of the ancient Mexican history commences with Chapter VII, and being resumed at Chapter XIII, continues unabated to the end of the volume.

THE MOUND-BUILDERS.—Some months ago we brought to the attention of our readers a paper, by Dr. Daniel G. Brinton, on the identity of the Mound-Builders and the Choctaws. On Tuesday evening, Feb. 5, Professor Cyrus Thomas, of the Bureau of Ethnology, read a paper before the Washington Anthropological Society with the following title: "Were the Cherokees mound-builders?" Now this is a very different question from that which would ask, "Were the Mound-Builders Cherokees?" Professor Thomas is now the archæologist of the Bureau of Ethnology and made extensive explorations in North Carolina during the past two seasons. These have brought to light two facts: (1) That mounds in the Cherokee region, of identical outward appearance,

have revealed Cherokee and typical Mound-Builder implements; and (2) from both these classes of works have been taken brass, iron, and glass objects. Specimens of all these classes of finds were exhibited at the meeting. About the same time that Professor Thomas read his paper, Professor F. W. Putnam sent us an abstract of an account of his recent archæological excursions in Wisconsin and Ohio, given at the meeting of the American Antiquarian Society, October 22. Comparing the two papers, one could hardly fail to see that a great change of opinion has taken place among our American archæologists concerning the Mound-Builders. Indeed, most investigators would advise us to drop the capital letters. As long, however, as eminent archæologists are troubled to find out who were the Mound-Builders, there is certainly a people called the Mound-Builders that remain to be found out. Now it is precisely this lost people to whom the capital letters apply. That those researches have accomplished much toward dispelling many ancient illusions, no one will dispute. The Mound-Builders probably were not so numerous, so highly organized socially, nor so cultivated as many have held. Neither were their successors within the area of the United States so degraded as they have been made out. The chasm, therefore, so far as culture is concerned, between the two peoples, the Mound-Builders and the modern Indians, has been bridged over by Thomas Putnam and others. No one has ever seen a tribe of homeless nomads on this continent. Mr. Morgan's investigations, followed up more minutely by Mr. Dorsey, have revealed an intricacy of social structure truly astonishing even among tribes called nomads.

Now these discoveries may turn our heads; and we are in danger of running into the other extreme of maintaining that the Mound-Builders were the ancestors of our modern Indians living on the same areas—which cannot yet be proved. That much can be said in its favor, that the attempt to prove it has awakened a lively interest in American archæology, and that the subject is one of legitimate inquiry, no one for a moment can doubt.

ON THE ATHABASCA DISTRICT OF THE CANADIAN NORTHWEST TERRITORY.[1]—That which gives value to this paper for the anthropologist is the table of statistics of the Athabasca and Mackenzie redskin population, including women and children.

	Great Slave Lake.		
Fort Resolution, 1863–64	Chipewyans	245	
	Yellow Knives	332	577
Fort Rae, 1864	Dog-ribs		788
	Mackenzie.		
Providence, 1871	Slaves or Etcha-ottiné		300
Blake Lake river, 1878	Etcha-ottiné		115
Hay river, 1874	" "		100
Fort Simpson, 1873	" "		300

[1] By the Rev. Emile Petitot. Map. Proc. Roy. Geog. Soc., 1883. Nov., pp. 633–655.

Mackenzie.

Forts Norman and Franklin (Bear lake), 1869....	Slaves or Etcha-ottiné	97	
	Dog-ribs	47	
	Mountain Indians	43	
	Hareskins	85	272
Fort Good Hope, 1867	Hareskins		422
Fort Macpherson (Peel R.), 1866, including La Pierre's House	Dindjie or Loucheux Quarrelers, Kutchin		290
	Eskimo of the Anderson	250	
	Eskimo of Mackenzie	300	550
Forts Leard and Nelson	Slaves		500
Population of the Mackenzie			4214

Athabasca.

Forts Chipewyan and Smith, 1879	Chipewyans	537	
	Crees	86	623
Fond du Lac, 1879	Caribou-eaters		318
Vermilion (Peace river), 1879	Beavers	234	
	Crees	6	240
Fort MacMurray (Athabasca river), 1879	Chipewyans	31	
	Crees	22	53
Fort Dunnegan (Peace river), 1879	Beavers & Sécanais	195	
Fort St. John (Peace R.), 1879. Lesser Slave L..	Crees	137	332
	Sécanais		195
Population of Athabasca			1761
Maximum total			5975

MICROSCOPY AND HISTOLOGY.[1]

SECTIONS OF DIATOMS.—Dr. J. H. L. Flögel's paper on "Researches on the structure of cell-walls of Diatoms" was brought before the meeting by Mr. J. Mayall, Jr., who, in his preliminary remarks, said that it would be remembered that some time ago they had heard reports that some one abroad was making sections of diatoms, and he was requested by Mr. Crisp to institute inquiries with the view of bringing the method before the society. He subsequently found that this work was being done by Dr. Flögel, of Holstein, who, there appeared no reason to doubt, was not only a skilled and competent observer, but that he possessed every kind of appliance for making careful observations. Having ascertained this, the next thing was to obtain specimens of actual sections of diatoms, without which it was of course not possible to form any satisfactory judgment on the matter. He was fortunate in persuading Dr. Schröder, now resident in London, to write to Dr. Flögel upon the subject, and in the result they had received a very elaborate paper accompanied by a dozen slides and a number of photographs and drawings in illustration.

A careful examination of the slides showed that Dr. Flögel was thoroughly familiar with the finest processes of mounting, and with all that had been done by Möller. One of the slides

[1] Edited by Dr. C. O. WHITMAN, Mus. Comp. Zool., Cambridge, Mass.

was exhibited in the room under a $\frac{1}{25}$ in. objective by Mr. Powell. It was a section of *Triceratium favus*, and the excellence of the specimen gave rise to the impression that something even more difficult than this could be accomplished. Amongst the other specimens sent were some very clean-cut sections giving an exceptionally clear image. It was stated by Dr. Flögel that as many as 174 transverse sections had been made of one diatom., all of which could be plainly identified as belonging to the same diatom. Mr. Mayall said that he could not pledge himself as to the correctness or otherwise of the theory set up by the author of the paper, as the subject was not one which he had made his own, although he had taken some pains to translate the paper for publication in the journal of the society.

Mr. Mayall then read an abstract of the paper to the meeting, and the subject was discussed by Mr. Curties, Mr. Crisp and other fellows.

The chairman in proposing a vote of thanks to Mr. Flögel for his paper, said that he was sure the society would feel doubly indebted to Mr. Mayall for the exertions which he had made to procure the paper, and also for the trouble he had taken in the matter of translation.

Mr. W. J. Sollas's letter on the subject of cutting sections of diatoms was formally laid before the meeting. It had reference to the paper of Dr. Flögel, read at the December meeting, and was also intended to be read at that meeting, but did not come to hand until the meeting was over, when it was informally communicated to those present. The letter was as follows:

"For some time past I have been engaged in cutting sections of diatoms. My plan is to scrape off a green slime from our river mud, consisting chiefly of *Pleurosigma zigzag*, a large species suitable for cutting. The slime, together with some mud unavoidably gathered at the same time, is placed in a saucer and covered with a piece of muslin, which lies in immediate contact with the mud, while a film of water lies above it. The saucer is now exposed to daylight and the diatoms creep through the muslin, collecting in a consistent film on its upper surface. The muslin may now be lifted from the mud; it comes away clean, bringing all the diatoms with it, but leaving the mud. The muslin with the diatom film is now immersed in the usual hardening and staining reagents. I have used a mixture of chromic and osmic acids and absolute alcohol for hardening; borax-carmine, hæmatoxylin and eosin for staining. When duly stained and hardened the diatom films may be removed from the muslin without difficulty and cut either by imbedding in pure paraffine (melting point 58°) and mounting in Canada balsam, or by freezing in gelatine jelly, which allows one to cut *consistent sections which may be mounted direct in glycerine* on a glass slide without passing through water. By employing these two processes I have made

out the internal structure of diatoms, and believe that I can detect fine protoplasmic threads proceeding from the protoplasm that surrounds the nucleus and passing through apertures in the median keel. I am not yet, however, in a position to demonstrate this with absolute certainty, but hope to do so soon."—*Jour. of the Roy. Micros. Soc., Feb., 1884.*

KILLING HYDROID ZOOPHYTES AND POLYZOA WITH THE TENTACLES EXTENDED.—H. C. Chadwick recommends the polyzoön to be placed in a small beaker or clear glass bottle, and allowed to remain at rest for several hours. Now take a dipping-tube, drawn out to a very fine point, and charge it with absolute alcohol. Having ascertained by means of a pocket-lens that the polypides are fully extended, allow the alcohol to drop very gently from the point of the tube which should be held just above the surface of the water. The success of the experiment depends largely upon the care with which the first quantity of alcohol is introduced into the water. After the lapse of an hour, if the polypides are still extended, a further quantity of alcohol is added until the quantity reaches sixty per cent.

After passing through seventy-five per cent alcohol, the specimens may be kept in ninety per cent of the same until required for mounting. Experiments with alcohol upon hydroid zoöphytes were not so successful, but Kleinenberg's picrosulphuric acid solution gave excellent results. The use of this reagent is attended with much less difficulty than that of alcohol. If the subject of the experiment is a zoöphyte, such as *Aglaophenia pluma* or *Plumularia setacea*, it must be allowed to remain some hours until the polypides are fully extended. Kleinenberg's fluid must then be introduced by means of a dipping-tube. It may be allowed to flow over the specimen in a continuous stream until the whole of the water assumes a golden-yellow color. The reagent causes instant death, so that the specimens may be transferred immediately to sixty per cent, and afterwards to seventy-five per cent alcohol, allowing them to remain in each solution for some hours. Keep in ninety per cent alcohol. From four to six minutes' immersion in Martindale's picrocarmine staining fluid is sufficient to stain specimens killed by either of the above methods.—*Jour. of the Roy. Micros. Soc., Feb., 1884.*

MOUNTING FLUID FOR ALGÆ.—For preserving the cell-contents and the natural color and form of desmids, volvox and other algæ, G. W. Morehouse finds a mounting fluid made as follows to act well: Dissolve fifteen grains of acetate of copper in a mixture of four fluid ounces of camphor water, four fluid ounces of distilled water and twenty minims of glacial acetic acid; add eight fluid ounces of Price's glycerine, and filter. When sections of plant-stems or other vegetable specimens are mounted in this fluid, the protoplasm is preserved. If in any case it is thought desi-

rable to increase or diminish the specific gravity of the preservative, the proportion of glycerine may be changed. Used as above, or modified as indicated, he thinks it also a trustworthy medium for mounting Infusoria and the softer animal tissues.—*Jour. of the Roy. Micros. Soc., Feb., 1884.*

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SCIENTIFIC NEWS.

— The thirty-third meeting of the American Association for the Advancement of Science will be held at Philadelphia, Penna., Sept. 4–10, 1884.

The British Association has invited the members of the American Association to join in the meeting at Montreal, and the American Association and the local committee of Philadelphia have invited the members of the British Association, with their near relatives who may be with them, to take part in the Philadelphia meeting.

A series of receptions will be offered the association and its guests, including one at the Academy of Music after the president's address; a reception at the Academy of the Fine Arts; a garden party at Haverford College, and a microscopical exhibition at the Academy of Natural Sciences. The botanical section of the Academy of Natural Sciences will organize botanical excursions, and will also hold a special meeting at the Academy for Botanists. There will be visits to the Internatianal Electrical Exhibition, the Zoölogical Gardens, Fairmount Park, Independence Hall and other places of interest, and the various institutions in the city will welcome the association to their halls. Several excursions will be offered to take place during the session, to the sea-shore, the coal regions and other points of interest, and possibly limited excursions to more distant points after the meeting.

The meeting will be called to order, in general session, at 10 o'clock on Thursday morning, Sept. 4th, in the Academy of Music, by President C. A. Young, of Princeton, who will resign the chair to the president-elect, Professor J. P. Lesley, of Philadelphia. After the adjournment of the general session, the sections will organize in their respective halls. General sessions and sections will be held on Friday. The vice-presidents of the sections will probably give their addresses during the day, and in the evening President Young will deliver his address at the Academy of Music, after which there will be a reception tendered to the members of the association, and their invited guests, by the local committee and citizens of Philadelphia. Saturday will probably be given up to excursions and receptions. The general programme for the rest of the meeting will be similar to that at previous meetings.

The headquarters of the association will be at the Academy of

Music, which is on Broad street, near the station of the Pennsylvania railroad and several large hotels. The sections will be amply accommodated in other halls in the immediate vicinity.

The offices of the permanent secretary and local committee, the association post-office, etc., will be at the Academy of Music after Sept. 1st; previous to that they will be at the Academy of Natural Sciences. The permanent secretary will establish his office in Philadelphia on August 22.

All matters relating to membership, the presentation of papers and business to come before the association, will be attended to by the *permanent secretary* at his office in *Salem, Mass., up to August 20.* After this date and until the meeting has adjourned, the address of the permanent secretary will be HOTEL LAFAYTTE, Philadelphia, Pa.

— Prizes given by the French Academy.—The "Prix Francœur" for discoveries in real or applied mathematics, was unanimously awarded to M. Emile Barbier, the laureate of 1882.

The prize of 6000 francs for studies calculated to increase the efficiency of the navy, was divided between M. Taurines, to whom 3000 francs was allotted for his forthcoming work entitled "Steam engines: a historical and critical account of the dynametric results of the working of marine engines," M. Germain, to whom 2000 francs was given for his "Theoretical and practical treatise upon Hydrography," and M. A. de Magnac, who received 1000 francs for a work entitled "New Astronomical Navigation," published in 1877, and the result of the joint labor of M. de Magnac and the deceased M. Yvon de Villarceau.

The "Prix Poncelet" was given to M. G. H. Halphen; the Montyon prize was parted between M. Leon Francq for perfecting Lamm's steam-engine, and M. L. Renouf for a mathematical instrument designed to simplify the taking of levels at sea; and the Plumey prize was given to the lieutenant of the *Jacquemier* for the invention of the "cinemometer," which effects transmission of movement by means of rachet-wheels and levers.

In astronomy the "Prix Lalande" was awarded to MM. Bonquet de la Gyre, de Bernardieres, Courcelle-Senevil, Fleuriais, Hatt, Perrotin, Bassot, Bigourdain and Callandreau, the members of the French expedition to observe the transit of Venus in 1882; while the "Prix Valz" was given to M. Stephan, the director of the Marseilles observatory, a savant whose discovery of seven hundred nebulæ does honor to French astronomy.

The "Prix Lacaze" (physics) was awarded to M. Henri Becquerel, engineer of roads and bridges, for the total of his works upon experimental physics.

The "Prix Montyon" (statistics) was allotted to the deceased M. Ch. Nicholas, author of the important work, "The Budgets of France since the commencement of the XIX century." This

work is complete, of exceptional merit, and indispensable to political economists, statesmen and financiers.

In chemistry the Jecker prize was given to M. Etard for his numerous and important discoveries in organic chemistry, among which may be cited his experiments upon the action of chlorochromic acid on organic substances, his researches on strychnine, on the ptomaines and on nicotine.

The "Prix Lacaze" was awarded to M. L. Cailletet for his investigations into the liquefaction of gases. He was the first to show the possibility of liquefying what are called the permanent gases, and science owes also to him a simple apparatus with which these experiments can be carried on without danger. *To be continued.*

— The French Society for the Advancement of Science, which will meet at Blois in September (4–11), has before it the duty of distributing a sum of about £800, being the first five years' accumulation of the legacy left to it in 1878, by M. Girard, to enable it to give rewards once in every five years to the person or persons who have most contributed to advance science upon the question of the antiquity of man with regard to geological formations.

— The number of applications for tickets for the British Association meeting this year is 772, and the council have resolved not to receive any more prior to the meeting at Montreal, when members and associates will be elected as usual.

— The Council of the British Association have resolved to receive the standing committee and fellows of the American Association on the footing of honorary members at the Montreal meeting.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Biological Society of Washington, May 3.—Communications were made by Dr. R. W. Shufeldt, U.S.A., on the occurrence of a pair of free ribs on the occipital bone of the large-mouthed black bass, *Micropterus salmoides;* by Mr. N. P. Scudder, observations upon the muskrat, *Fiber zibethicus;* and by Dr. Theodore Gill on the system of the Squali.

Boston Society of Natural History.—The annual meeting was held on May 7, 1884. Annual reports were made by the curator, secretary and treasurer, followed by the election of officers for 1884–5, and of candidates for membership. The third award of the grand Walker prize was announced, and the committee on the annual Walker prize made its report, awarding it to Dr. Tuttle for his essay on the anatomy and embryology of *Lunatia heros.* Mr. F. W. Putnam spoke of some interesting recent discoveries relating to the antiquity of man in America, in

the Trenton gravels and in Nicaragua, and also gave evidence of the practice of cremation by an ancient people in the Little Miami valley. Dr. M. E. Wadsworth read a paper on the origin of ore deposits.

The last general meeting was held on May 21. Mr. S. Garman spoke of certain works of the Indians, and Professor A. Hyatt discussed the affinities of Beatricea.

NEW YORK ACADEMY OF SCIENCES, May 12.—The following papers were announced: The colored marbles of Lake Champlain (illustrated with a suite of specimens), by Mr. Arthur H. Elliott; a remarkable Chlorophane from Amelia county, Virginia, by Mr. George F. Kunz.

May 26.—The following papers were announced: Bees and other hoarding insects: their specialization into males, females and workers, by Mr. E. A. Curley; The origin of Puget sound and its connected system of tideways, by Professor John S. Newberry.

APPALACHIAN MOUNTAIN CLUB, May 14.—The following paper was presented: A photographic study of the Matterhorn, by Professor Edward C. Pickering.

AMERICAN PHILOSOPHICAL SOCIETY, Jan. 18.—Professor Cope exhibited fossils of the family Oreodontidæ, and described their characteristic structure and geological relations. A drawing of a sarcophagus in Memorial Hall, with a translation of the legend on the cover, by Commodore McCauley, were exhibited. Dr. Frazer communicated a table of barometric levels taken by him recently in Texas and New Mexico, and described the geological structure of the neighborhood. Professor Cope remarked that the formation which forms the banks of the Rio Grande at Laredo, Texas, is in all probability the Laramie. It contains at that point a thick bed of pure lignite. Above Laredo, on both sides of the river, an excellent lignite is mined. The wide valley of the Rio Grande as far as the eastern ranges of the Sierra Madre is probably of Laramic age, as Dr. C. A. White reports fossil mollusca of that age from near Lampazas, at the foot of the mountains. Mr. Arthur Schott (U. S. Mex. Bound. Survey I, Geology, p. 35), first observed these lignites, and Mr. Conrad pointed out the existence of Claiborne Eocene beds in the same region (loc. cit., p. 141). Professor Cope stated that the Claiborne beds rested immediately on the Laramie at Laredo.

Feb. 1.—Professor Cope exhibited specimens of Creodonta, and sketched the classification of that order.

Feb. 15.—Sections of the anthracite coal measures, recently executed by the Geological Survey of the State, were exhibited.

Dr. Frazer exhibited copies of hieroglyphs found in the Puerto San Antonio, Coahuila, Mexico, not previously described, and also spoke of his discovery of a sacrificial stone of great weight and

age, lying sixty or seventy miles distant from any similar rock, and in a mountain pass famous in history. Size five to six by three to four feet high. The edges are full of sharp serrations, and the weight must be at least five and one-half tons. The stone has a notch by which the blood flowed off.

March 7.—Professor Cope read a paper entitled "On the Structure of the Skull in the Elasmobranch genus Didymodus."

Mr. Ashburner presented some notes "On the aneroid hypsometry," and exhibited a self-registering field instrument.

March 21.—A communication from Professor Claypole, entitled "On the Clinton and other shales composing the Fifth Group of Rogers in the first survey of Pennsylvania," was read.

April 4.—Professor Lesley read from a letter of J. F. Carll, a correction of the horizon of *Eurypterus pennsylvanicus*, described by Mr. C. E. Hall. The fossil was found seventy-two feet above the mouth of the Pithole well, *i. e.*, 167 feet above the Berea or Pithole grit.

Mr. Blasius read a paper on the unhealthy condition of certain portions of great cities, owing to prevalent winds, and spoke of the necessity of rapid transit.

NATURAL SCIENCE ASSOCIATION OF STATEN ISLAND, May 10.—In the absence of the president, Dr. Britton was elected chairman *pro tem.* Three new members were elected and other business transacted, after which Mr. Hollick read a paper upon "Recent discoveries of Indian Implements at Tottenville." The following is a complete list of the different objects thus far found: one axe, one pipe, five hammer stones, ten arrow-heads, thirty-seven net sinkers, seven miscellaneous and innumerable chips and fragments. It is but little more than a year since the first of these was accidentally discovered while on a field excursion to the locality. Since then, whenever the place has been visited and searched, relics have invariably been found. Mr. George F. Kunz, of New York, who was present by invitation, then presented the stone head found near Clifton, and gave the following account of the same: As now preserved it shows the material of which it was formed to be a brown sandstone, apparently more compact than the common New Jersey sandstone, and composed almost entirely of grains of quartz with an occasional small pebble, one of these, measuring one-fifth of an inch across, is on the bridge of the nose, and another, a little smaller, in the center of the forehead. The features are too well cut for a common off-hand piece of work by a stonemaker; the style is not Egyptian or Eastern; rendering it unlikely that it is a part of an antiquity thrown away by some sailor; it is rather Mexican, and still more resembles Aztec work. This leads to the inference that it is probably of Indian origin, or if not, it is remotely possible that it was made by the early Dutch.